Companion to a Critical Analysis of Parameter Adaptation in Ant Colony Optimization

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Applying parameter adaptation means operating on parameters of the algorithm at hand during the solution of an instance. For ant colony optimization, several parameter adaptation methods have been proposed. In the literature, these methods have been shown to improve the quality of the results achieved in some particular contexts. In particular, they proved to be successful when applied to novel ACO variants for tackling problems that are not a classical testbed for optimization algorithms. In this paper, we show that the adaptation methods proposed so far do not improve, and even worsen, the performance when applied to high performing ACO algorithm for some classical combinatorial optimization problems.

* This work was supported by the META-X project, an *Action de Recherche Concertée* funded by the Scientific Research Directorate of the French Community of Belgium and by the European Union through the ERC Advance Grant "E-SWARM: Engineering Swarm Intelligence Systems" (contract 246939). Mauro Birattari and Thomas Stützle acknowledge support from the Belgian F.R.S.-FNRS, of which they are Research Associates. The work of Paola Pellegrini is funded by a Bourse d'excellence Wallonie-Bruxelles International.

Table 1: Average relative error for each set of instances of the **TSP**. Comparison between $\mathcal{MM}$AS applying the five parameter adaptation methods and applying no adaptation. Setting suggested in the **literature** for non-adapted parameters. Results obtained adapting each single parameter. A bullet following the value indicates that no adaptation is statistically better than adaptation. A star indicates that no adaptation is statistically worse than adaptation.

instance set	runs	q_0	β	ρ	m	α	nn
SAc							
$TSP(2000,u)$	short	$-.0072^{\star}$	$-.0013^{\star}$	$-.0080^{\star}$	$.0014^{\bullet}$	$-.0050^{\star}$	$.0034^{\bullet}$
$TSP(2000,c)$	short	$-.0024^{\star}$	$.0007^{\star}$	$-.0023^{\star}$	$.0015^{\bullet}$	$-.0019^{\star}$	$.0030^{\bullet}$
$TSP(2000,x)$	short	$-.0053^{\star}$	$-.0007^{\star}$	$-.0049^{\star}$	$.0015^{\bullet}$	$-.0035^{\star}$	$.0028^{\bullet}$
$TSP(x,u)$	short	$-.0101^{\star}$	$-.0009^{\star}$	$-.0099^{\star}$	$.0009^{\bullet}$	$-.0060^{\star}$	$.0031^{\bullet}$
$TSP(x,c)$	short	$-.0035^{\star}$	$-.0001$	$-.0035^{\star}$	$.0000$	$-.0030^{\star}$	$.0020^{\bullet}$
$TSP(x,x)$	short	$-.0066^{\star}$	$.0000$	$-.0067^{\star}$	$.0012^{\bullet}$	$-.0043^{\star}$	$.0026^{\bullet}$
$TSP(2000,u)$	long	$.0008$	$.0025$	$.0025^{\bullet}$	$.0005^{\bullet}$	$.0033$	$.0024^{\bullet}$
SAcb							
$TSP(2000,u)$	short	$-.0062^{\star}$	$-.0008^{\star}$	$-.0044^{\star}$	$.0005$	$-.0050^{\star}$	$.0031^{\bullet}$
$TSP(2000,c)$	short	$-.0027^{\star}$	$.0013^{\star}$	$-.0016^{\star}$	$.0014^{\bullet}$	$-.0018^{\star}$	$.0028^{\bullet}$
$TSP(2000,x)$	short	$-.0044^{\star}$	$-.0002$	$-.0029^{\star}$	$.0006$	$-.0043^{\star}$	$.0027^{\bullet}$
$TSP(x,u)$	short	$-.0079^{\star}$	$-.0004$	$-.0057^{\star}$	$-.0010$	$-.0069^{\star}$	$.0031^{\bullet}$
$TSP(x,c)$	short	$-.0041^{\star}$	$-.0002$	$-.0017^{\star}$	$.0000$	$-.0031^{\star}$	$.0013^{\bullet}$
$TSP(x,x)$	short	$-.0054^{\star}$	$.0002$	$-.0025^{\star}$	$-.0003$	$-.0049^{\star}$	$.0025^{\bullet}$
$TSP(2000,u)$	long	$.0038^{\bullet}$	$.0036^{\bullet}$	$.0067$	$.0033^{\bullet}$	$.0052$	$.0051^{\bullet}$
SAcm							
$TSP(2000,u)$	short	$-.0122^{\star}$	$-.0006^{\star}$	$-.0060^{\star}$	$.0035^{\bullet}$	$-.0018^{\star}$	$.0028^{\bullet}$
$TSP(2000,c)$	short	$-.0041^{\star}$	$.0007$	$-.0008$	$.0019^{\bullet}$	$-.0017^{\star}$	$.0029^{\bullet}$
$TSP(2000,x)$	short	$-.0069^{\star}$	$.0000$	$-.0037^{\star}$	$.0022^{\bullet}$	$-.0026^{\star}$	$.0031^{\bullet}$
$TSP(x,u)$	short	$-.0141^{\star}$	$.0000$	$-.0081^{\star}$	$.0027^{\bullet}$	$-.0017^{\star}$	$.0028^{\bullet}$
$TSP(x,c)$	short	$-.0050^{\star}$	$-.0001$	$-.0020^{\star}$	$.0009^{\bullet}$	$-.0031^{\star}$	$.0015^{\bullet}$
$TSP(x,x)$	short	$-.0090^{\star}$	$.0005$	$-.0042^{\star}$	$.0020^{\bullet}$	$-.0018^{\star}$	$.0025^{\bullet}$
$TSP(2000,u)$	long	$.0072$	$.0089^{\bullet}$	$.0086$	$.0071^{\bullet}$	$.0096$	$.0081^{\bullet}$
SAa							
$TSP(2000,u)$	short	$-.0095^{\star}$	$-.0014^{\star}$		$-.0105^{\star}$	$.0024$	
$TSP(2000,c)$	short	$-.0013^{\star}$	$.0029^{\bullet}$		$-.0014^{\star}$	$.0029^{\bullet}$	
$TSP(2000,x)$	short	$-.0053^{\star}$	$.0000$		$-.0062^{\star}$	$.0023^{\bullet}$	
$TSP(x,u)$	short	$-.0113^{\star}$	$-.0004$		$-.0126^{\star}$	$.0016^{\bullet}$	
$TSP(x,c)$	short	$-.0038^{\star}$	$.0007$		$-.0049^{\star}$	$.0011^{\bullet}$	
$TSP(x,x)$	short	$-.0067^{\star}$	$.0008$		$-.0081^{\star}$	$.0019^{\bullet}$	
$TSP(2000,u)$	long	$.0154$	$.0022^{\bullet}$		$.0141$	$.0023^{\bullet}$	
LS							
$TSP(2000,u)$	short	$-.0095^{\star}$	$-.0014^{\star}$		$-.0105^{\star}$	$.0024$	
$TSP(2000,c)$	short	$-.0013^{\star}$	$.0029^{\bullet}$		$-.0014^{\star}$	$.0029^{\bullet}$	
$TSP(2000,x)$	short	$-.0053^{\star}$	$.0000$		$-.0062^{\star}$	$.0023^{\bullet}$	
$TSP(x,u)$	short	$-.0113^{\star}$	$-.0004$		$-.0126^{\star}$	$.0016^{\bullet}$	
$TSP(x,c)$	short	$-.0038^{\star}$	$.0007$		$-.0049^{\star}$	$.0011^{\bullet}$	
$TSP(x,x)$	short	$-.0067^{\star}$	$.0008$		$-.0081^{\star}$	$.0019^{\bullet}$	
$TSP(2000,u)$	long	$.0154$	$.0022^{\bullet}$		$.0141$	$.0023^{\bullet}$	

Table 2: Average relative error for each set of instances of the **TSP**. Comparison between $\mathcal{MM}$AS applying the five parameter adaptation methods and applying no adaptation. Setting selected through off-line tuning with **low tuning effort** for non-adapted parameters. Results obtained adapting each single parameter. A bullet following the value indicates that no adaptation is statistically better than adaptation. A star indicates that no adaptation is statistically worse than adaptation.

instance set	runs	q_0	β	ρ	m	α	nn
SAc							
$TSP(2000,u)$	short	.0012$^\bullet$	.0011$^\bullet$	.0034$^\bullet$	.0004$^\bullet$	.0036$^\bullet$	.0012$^\bullet$
$TSP(2000,c)$	short	.0023$^\bullet$	.0021$^\bullet$	.0014$^\bullet$	.0005$^\bullet$	.0013$^\bullet$	.0014$^\bullet$
$TSP(2000,x)$	short	.0046$^\bullet$	.0040$^\bullet$	.0011$^\bullet$	.0002$^\bullet$	.0016$^\bullet$	.0017$^\bullet$
$TSP(x,u)$	short	.0004	.0011$^\bullet$	.0072$^\bullet$	.0006$^\bullet$	.0050$^\bullet$	.0016$^\bullet$
$TSP(x,c)$	short	.0014$^\bullet$	.0018$^\bullet$	.0012$^\bullet$	.0000	.0013$^\bullet$	.0008$^\bullet$
$TSP(x,x)$	short	.0022$^\bullet$	.0040$^\bullet$	.0010$^\bullet$	.0007$^\bullet$	.0010$^\bullet$	.0006$^\bullet$
$TSP(2000,u)$	long	.0009$^\bullet$	.0025$^\bullet$	.0025$^\bullet$	.0006$^\bullet$	.0043$^\bullet$	.0025$^\bullet$
SAcb							
$TSP(2000,u)$	short	.0029$^\bullet$	.0029$^\bullet$	.0087$^\bullet$	.0028$^\bullet$	.0057$^\bullet$	.0035$^\bullet$
$TSP(2000,c)$	short	.0052$^\bullet$	.0059$^\bullet$	.0058$^\bullet$	.0048$^\bullet$	.0048$^\bullet$	.0056$^\bullet$
$TSP(2000,x)$	short	.0144$^\bullet$	.0072$^\bullet$	.0066$^\bullet$	.0070$^\bullet$	.0100$^\bullet$	.0120$^\bullet$
$TSP(x,u)$	short	.0022$^\bullet$	.0038$^\bullet$	.0117$^\bullet$	.0024$^\bullet$	.0065$^\bullet$	.0039$^\bullet$
$TSP(x,c)$	short	.0027$^\bullet$	.0032$^\bullet$	.0028$^\bullet$	.0030$^\bullet$	.0035$^\bullet$	.0036$^\bullet$
$TSP(x,x)$	short	.0084$^\bullet$	.0048$^\bullet$	.0039$^\bullet$	.0057$^\bullet$	.0066$^\bullet$	.0073$^\bullet$
$TSP(2000,u)$	long	.0036$^\bullet$	.0039$^\bullet$	.0077$^\bullet$	.0036$^\bullet$	.0062$^\bullet$	.0053$^\bullet$
SAcm							
$TSP(2000,u)$	short	.0054$^\bullet$	.0056$^\bullet$	.0091$^\bullet$	.0055$^\bullet$	.0092$^\bullet$	.0069$^\bullet$
$TSP(2000,c)$	short	.0055$^\bullet$	.0067$^\bullet$	.0060$^\bullet$	.0055$^\bullet$	.0061$^\bullet$	.0062$^\bullet$
$TSP(2000,x)$	short	.0065$^\bullet$	.0106$^\bullet$	.0066$^\bullet$	.0070$^\bullet$	.0082$^\bullet$	.0083$^\bullet$
$TSP(x,u)$	short	.0031$^\bullet$	.0048$^\bullet$	.0117$^\bullet$	.0034$^\bullet$	.0105$^\bullet$	.0057$^\bullet$
$TSP(x,c)$	short	.0049$^\bullet$	.0069$^\bullet$	.0059$^\bullet$	.0050$^\bullet$	.0069$^\bullet$	.0052$^\bullet$
$TSP(x,x)$	short	.0074$^\bullet$	.0095$^\bullet$	.0070$^\bullet$	.0065$^\bullet$	.0076$^\bullet$	.0077$^\bullet$
$TSP(2000,u)$	long	.0078$^\bullet$	.0084$^\bullet$	.0096$^\bullet$	.0076$^\bullet$	.0106$^\bullet$	.0087$^\bullet$
SAa							
$TSP(2000,u)$	short	.0070$^\bullet$	.0070$^\bullet$		.0070$^\bullet$	.0070	
$TSP(2000,c)$	short	.0120$^\bullet$	.0121$^\bullet$		.0120$^\bullet$	.0119$^\bullet$	
$TSP(2000,x)$	short	.0066$^\bullet$	.0067$^\bullet$		.0066$^\bullet$	.0066$^\bullet$	
$TSP(x,u)$	short	.0064$^\bullet$	.0064$^\bullet$		.0065$^\bullet$	.0065$^\bullet$	
$TSP(x,c)$	short	.0056$^\bullet$	.0057$^\bullet$		.0057$^\bullet$	.0056$^\bullet$	
$TSP(x,x)$	short	.0035$^\bullet$	.0036$^\bullet$		.0036$^\bullet$	.0036$^\bullet$	
$TSP(2000,u)$	long	.0027$^\bullet$	.0027$^\bullet$		.0028$^\bullet$	.0027$^\bullet$	
LS							
$TSP(2000,u)$	short	.0069$^\bullet$	.0074$^\bullet$		.0095$^\bullet$	.0072$^\bullet$	
$TSP(2000,c)$	short	.0118$^\bullet$	.0119$^\bullet$		.0110$^\bullet$	.0118$^\bullet$	
$TSP(2000,x)$	short	.0064$^\bullet$	.0071$^\bullet$		.0055$^\bullet$	.0056$^\bullet$	
$TSP(x,u)$	short	.0062$^\bullet$	.0070$^\bullet$		.0110$^\bullet$	.0064$^\bullet$	
$TSP(x,c)$	short	.0054$^\bullet$	.0049$^\bullet$		.0052$^\bullet$	.0053$^\bullet$	
$TSP(x,x)$	short	.0037$^\bullet$	.0035$^\bullet$		.0036$^\bullet$	.0039$^\bullet$	
$TSP(2000,u)$	long	.0026$^\bullet$	.0042$^\bullet$		.0072$^\bullet$	.0029$^\bullet$	

Table 3: Average relative error for each set of instances of the **TSP**. Comparison between $\mathcal{MM}$AS applying the five parameter adaptation methods and applying no adaptation. Setting selected through off-line tuning with **medium-low tuning effort** for non-adapted parameters. Results obtained adapting each single parameter. A bullet following the value indicates that no adaptation is statistically better than adaptation. A star indicates that no adaptation is statistically worse than adaptation.

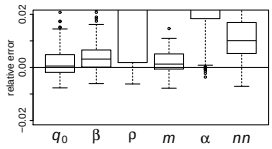
instance set	runs	q_0	β	ρ	m	α	nn
SAc							
$TSP(2000,u)$	short	.0010$^\bullet$	.0019$^\bullet$	.0044$^\bullet$	.0004	.0049$^\bullet$	.0011$^\bullet$
$TSP(2000,c)$	short	.0025$^\bullet$	.0024$^\bullet$	.0014$^\bullet$	.0006$^\bullet$	.0012$^\bullet$	.0012$^\bullet$
$TSP(2000,x)$	short	.0039$^\bullet$	.0015$^\bullet$	.0005$^\bullet$	−.0009	.0016$^\bullet$	.0014$^\bullet$
$TSP(x,u)$	short	.0005$^\bullet$	.0022$^\bullet$	.0090$^\bullet$	.0009$^\bullet$	.0042$^\bullet$	.0010$^\bullet$
$TSP(x,c)$	short	.0016$^\bullet$	.0017$^\bullet$	.0011$^\bullet$	.0000	.0008$^\bullet$	.0006$^\bullet$
$TSP(x,x)$	short	.0034$^\bullet$	.0039$^\bullet$	.0001$^\bullet$	.0002	.0007$^\bullet$	−.0001$^\bullet$
$TSP(2000,u)$	long	.0009$^\bullet$	.0022$^\bullet$	.0027$^\bullet$	.0006$^\bullet$	.0042$^\bullet$	.0013$^\bullet$
SAcb							
$TSP(2000,u)$	short	.0044$^\bullet$	.0049$^\bullet$	.0102$^\bullet$	.0045$^\bullet$	.0070$^\bullet$	.0048$^\bullet$
$TSP(2000,c)$	short	.0037$^\bullet$	.0035$^\bullet$	.0044$^\bullet$	.0036$^\bullet$	.0042$^\bullet$	.0043$^\bullet$
$TSP(2000,x)$	short	.0120$^\bullet$	.0050$^\bullet$	.0037$^\bullet$	.0063$^\bullet$	.0095$^\bullet$	.0115$^\bullet$
$TSP(x,u)$	short	.0018$^\bullet$	.0031$^\bullet$	.0102$^\bullet$	.0023$^\bullet$	.0060$^\bullet$	.0032$^\bullet$
$TSP(x,c)$	short	.0028$^\bullet$	.0029$^\bullet$	.0030$^\bullet$	.0027$^\bullet$	.0033$^\bullet$	.0032$^\bullet$
$TSP(x,x)$	short	.0089$^\bullet$	.0063$^\bullet$	.0057$^\bullet$	.0068$^\bullet$	.0085$^\bullet$	.0087$^\bullet$
$TSP(2000,u)$	long	.0020$^\bullet$	.0027$^\bullet$	.0057$^\bullet$	.0025$^\bullet$	.0048$^\bullet$	.0030$^\bullet$
SAcm							
$TSP(2000,u)$	short	.0063$^\bullet$	.0070$^\bullet$	.0120$^\bullet$	.0064$^\bullet$	.0109$^\bullet$	.0079$^\bullet$
$TSP(2000,c)$	short	.0044$^\bullet$	.0061$^\bullet$	.0054$^\bullet$	.0051$^\bullet$	.0057$^\bullet$	.0051$^\bullet$
$TSP(2000,x)$	short	.0022	.0069$^\bullet$	.0025$^\bullet$	.0022	.0050$^\bullet$	.0039$^\bullet$
$TSP(x,u)$	short	.0029$^\bullet$	.0042$^\bullet$	.0118$^\bullet$	.0030$^\bullet$	.0088$^\bullet$	.0047$^\bullet$
$TSP(x,c)$	short	.0027$^\bullet$	.0055$^\bullet$	.0037$^\bullet$	.0024$^\bullet$	.0051$^\bullet$	.0028$^\bullet$
$TSP(x,x)$	short	.0059$^\bullet$	.0089$^\bullet$	.0062$^\bullet$	.0058$^\bullet$	.0066$^\bullet$	.0068$^\bullet$
$TSP(2000,u)$	long	.0053$^\bullet$	.0061$^\bullet$	.0060$^\bullet$	.0053$^\bullet$	.0097$^\bullet$	.0076$^\bullet$
SAa							
$TSP(2000,u)$	short	.0074$^\bullet$	.0082$^\bullet$		.0105$^\bullet$	.0074$^\bullet$	
$TSP(2000,c)$	short	.0101$^\bullet$	.0111$^\bullet$		.0098$^\bullet$	.0108$^\bullet$	
$TSP(2000,x)$	short	.0184$^\bullet$	.0193$^\bullet$		.0178$^\bullet$	.0172$^\bullet$	
$TSP(x,u)$	short	.0058$^\bullet$	.0066$^\bullet$		.0096$^\bullet$	.0063$^\bullet$	
$TSP(x,c)$	short	.0099$^\bullet$	.0097$^\bullet$		.0098$^\bullet$	.0098$^\bullet$	
$TSP(x,x)$	short	.0047$^\bullet$	.0045$^\bullet$		.0048$^\bullet$	.0044$^\bullet$	
$TSP(2000,u)$	long	.0016$^\bullet$	.0026$^\bullet$		.0042$^\bullet$	.0018$^\bullet$	
LS							
$TSP(2000,u)$	short	.0075$^\bullet$	.0075$^\bullet$		.0075$^\bullet$	.0075$^\bullet$	
$TSP(2000,c)$	short	.0104$^\bullet$	.0103$^\bullet$		.0103$^\bullet$	.0104$^\bullet$	
$TSP(2000,x)$	short	.0186$^\bullet$	.0186$^\bullet$		.0187$^\bullet$	.0287$^\bullet$	
$TSP(x,u)$	short	.0060$^\bullet$	.0060$^\bullet$		.0060$^\bullet$	.0060$^\bullet$	
$TSP(x,c)$	short	.0101$^\bullet$	.0103$^\bullet$		.0101$^\bullet$	.0102$^\bullet$	
$TSP(x,x)$	short	.0049$^\bullet$	.0050$^\bullet$		.0050$^\bullet$	.0049$^\bullet$	
$TSP(2000,u)$	long	.0017$^\bullet$	.0018$^\bullet$		.0017$^\bullet$	.0017$^\bullet$	

Table 4: Average relative error for each set of instances of the **TSP**. Comparison between $\mathcal{MM}$AS applying the five parameter adaptation methods and applying no adaptation. Setting selected through off-line tuning with **medium-high tuning effort** for non-adapted parameters. Results obtained adapting each single parameter. A bullet following the value indicates that no adaptation is statistically better than adaptation. A star indicates that no adaptation is statistically worse than adaptation.

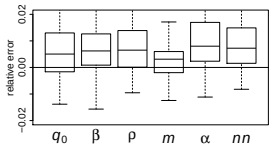
instance set	runs	q_0	β	ρ	m	α	nn
SAc							
$TSP(2000, u)$	short	.0009	.0017$^\bullet$	.0057$^\bullet$	.0005$^\bullet$	.0035$^\bullet$	.0009$^\bullet$
$TSP(2000, c)$	short	.0024$^\bullet$	.0022$^\bullet$	.0017$^\bullet$	.0004$^\bullet$	.0008$^\bullet$	.0008$^\bullet$
$TSP(2000, x)$	short	.0035$^\bullet$	.0030$^\bullet$	.0010$^\bullet$	−.0001	.0010$^\bullet$	.0012$^\bullet$
$TSP(x, u)$	short	.0005$^\bullet$	.0020$^\bullet$	.0082$^\bullet$	.0006$^\bullet$	.0048$^\bullet$	.0010$^\bullet$
$TSP(x, c)$	short	.0023$^\bullet$	.0030$^\bullet$	.0015$^\bullet$	.0000	.0014$^\bullet$	.0011$^\bullet$
$TSP(x, x)$	short	.0036$^\bullet$	.0047$^\bullet$	.0006$^\bullet$	.0002	.0010$^\bullet$	.0007$^\bullet$
$TSP(2000, u)$	long	.0006$^\bullet$	.0020$^\bullet$	.0029$^\bullet$	.0005$^\bullet$	.0046$^\bullet$	.0019$^\bullet$
SAcb							
$TSP(2000, u)$	short	.0026	.0037$^\bullet$	.0104$^\bullet$	.0023	.0054$^\bullet$	.0033$^\bullet$
$TSP(2000, c)$	short	.0040$^\bullet$	.0056$^\bullet$	.0047$^\bullet$	.0040$^\bullet$	.0042$^\bullet$	.0042$^\bullet$
$TSP(2000, x)$	short	.0099$^\bullet$	.0027$^\bullet$	.0025$^\bullet$	.0049$^\bullet$	.0082$^\bullet$	.0095$^\bullet$
$TSP(x, u)$	short	.0023$^\bullet$	.0041$^\bullet$	.0087$^\bullet$	.0026$^\bullet$	.0059$^\bullet$	.0036$^\bullet$
$TSP(x, c)$	short	.0031$^\bullet$	.0040$^\bullet$	.0031$^\bullet$	.0031$^\bullet$	.0039$^\bullet$	.0039$^\bullet$
$TSP(x, x)$	short	.0068$^\bullet$	.0034$^\bullet$	.0026$^\bullet$	.0038$^\bullet$	.0051$^\bullet$	.0065$^\bullet$
$TSP(2000, u)$	long	.0033$^\bullet$	.0043$^\bullet$	.0074$^\bullet$	.0034$^\bullet$	.0052$^\bullet$	.0040$^\bullet$
SAcm							
$TSP(2000, u)$	short	.0055$^\bullet$	.0063$^\bullet$	.0120$^\bullet$	.0057$^\bullet$	.0096$^\bullet$	.0076$^\bullet$
$TSP(2000, c)$	short	.0046$^\bullet$	.0060$^\bullet$	.0059$^\bullet$	.0055$^\bullet$	.0056$^\bullet$	.0051$^\bullet$
$TSP(2000, x)$	short	.0018	.0066$^\bullet$	.0022$^\bullet$	.0022$^\bullet$	.0040$^\bullet$	.0036$^\bullet$
$TSP(x, u)$	short	.0046$^\bullet$	.0061$^\bullet$	.0112$^\bullet$	.0047$^\bullet$	.0087$^\bullet$	.0053$^\bullet$
$TSP(x, c)$	short	.0051$^\bullet$	.0081$^\bullet$	.0059$^\bullet$	.0053$^\bullet$	.0064$^\bullet$	.0058$^\bullet$
$TSP(x, x)$	short	.0055$^\bullet$	.0091$^\bullet$	.0061$^\bullet$	.0053$^\bullet$	.0066$^\bullet$	.0061$^\bullet$
$TSP(2000, u)$	long	.0056$^\bullet$	.0062$^\bullet$	.0076$^\bullet$	.0055$^\bullet$	.0105$^\bullet$	.0080$^\bullet$
SAa							
$TSP(2000, u)$	short	.0073$^\bullet$	.0085$^\bullet$		.0111$^\bullet$	.0074$^\bullet$	
$TSP(2000, c)$	short	.0092$^\bullet$	.0101$^\bullet$		.0094$^\bullet$	.0098$^\bullet$	
$TSP(2000, x)$	short	.0041$^\bullet$	.0047$^\bullet$		.0030	.0027	
$TSP(x, u)$	short	.0058$^\bullet$	.0065$^\bullet$		.0099$^\bullet$	.0062$^\bullet$	
$TSP(x, c)$	short	.0087$^\bullet$	.0093$^\bullet$		.0089$^\bullet$	.0089$^\bullet$	
$TSP(x, x)$	short	.0010$^\bullet$	.0008$^\bullet$		.0012$^\bullet$	.0004$^\bullet$	
$TSP(2000, u)$	long	.0010$^\bullet$	.0021$^\bullet$		.0043$^\bullet$	.0016$^\bullet$	
LS							
$TSP(2000, u)$	short	.0074$^\bullet$	.0074$^\bullet$		.0075$^\bullet$	.0074$^\bullet$	
$TSP(2000, c)$	short	.0094$^\bullet$	.0094$^\bullet$		.0094$^\bullet$	.0094$^\bullet$	
$TSP(2000, x)$	short	.0043$^\bullet$	.0044$^\bullet$		.0043$^\bullet$	.0044$^\bullet$	
$TSP(x, u)$	short	.0060$^\bullet$	.0060$^\bullet$		.0060$^\bullet$	.0060$^\bullet$	
$TSP(x, c)$	short	.0090$^\bullet$	.0093$^\bullet$		.0091$^\bullet$	.0091$^\bullet$	
$TSP(x, x)$	short	.0011$^\bullet$	.0012$^\bullet$		.0012$^\bullet$	.0013$^\bullet$	
$TSP(2000, u)$	long	.0011$^\bullet$	.0012$^\bullet$		.0011$^\bullet$	.0011$^\bullet$	

Table 5: Average relative error for each set of instances of the **TSP**. Comparison between $\mathcal{MM}$AS applying the five parameter adaptation methods and applying no adaptation. Initial setting selected through off-line tuning with **high tuning effort**. Results obtained adapting each single parameter. A bullet following the value indicates that no adaptation is statistically better than adaptation. A star indicate that no adaptation is statistically worse than adaptation.

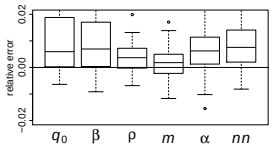
instance set	runs	q_0	β	ρ	m	α	nn
SAc							
$TSP(2000,u)$	short	.0021$^\bullet$	.0047$^\bullet$	.0167$^\bullet$	.0022$^\bullet$	.0227$^\bullet$	.0109$^\bullet$
$TSP(2000,c)$	short	.0055$^\bullet$	.0068$^\bullet$	.0071$^\bullet$	.0029$^\bullet$	.0097$^\bullet$	.0085$^\bullet$
$TSP(2000,x)$	short	.0109$^\bullet$	.0089$^\bullet$	.0037$^\bullet$	.0014$^\bullet$	.0064$^\bullet$	.0079$^\bullet$
$TSP(x,u)$	short	.0005	.0039$^\bullet$	.0192$^\bullet$	.0018$^\bullet$	.0213$^\bullet$	.0084$^\bullet$
$TSP(x,c)$	short	.0026$^\bullet$	.0052$^\bullet$	.0032$^\bullet$	.0004	.0073$^\bullet$	.0054$^\bullet$
$TSP(x,x)$	short	.0074$^\bullet$	.0088$^\bullet$	.0021$^\bullet$	.0013$^\bullet$	.0044$^\bullet$	.0054$^\bullet$
$TSP(2000,u)$	long	.0016$^\bullet$	.0042$^\bullet$	.0052$^\bullet$	.0012$^\bullet$	.0174$^\bullet$	.0107$^\bullet$
SAcb							
$TSP(2000,u)$	short	.0012$^\bullet$	.0052$^\bullet$	.0234$^\bullet$	.0026$^\bullet$	.0221$^\bullet$	.0120$^\bullet$
$TSP(2000,c)$	short	.0064$^\bullet$	.0073$^\bullet$	.0070$^\bullet$	.0042$^\bullet$	.0072$^\bullet$	.0104$^\bullet$
$TSP(2000,x)$	short	.0212$^\bullet$	.0079$^\bullet$	.0037$^\bullet$	.0032$^\bullet$	.0072$^\bullet$	.0103$^\bullet$
$TSP(x,u)$	short	.0011$^\bullet$	.0043$^\bullet$	.0234$^\bullet$	.0027$^\bullet$	.0224$^\bullet$	.0106$^\bullet$
$TSP(x,c)$	short	.0038$^\bullet$	.0036$^\bullet$	.0035$^\bullet$	.0038$^\bullet$	.0080$^\bullet$	.0082$^\bullet$
$TSP(x,x)$	short	.0148$^\bullet$	.0088$^\bullet$	.0024$^\bullet$	.0032$^\bullet$	.0051$^\bullet$	.0071$^\bullet$
$TSP(2000,u)$	long	.0024$^\bullet$	.0042$^\bullet$	.0122$^\bullet$	.0032$^\bullet$	.0197$^\bullet$	.0120$^\bullet$
SAcm							
$TSP(2000,u)$	short	.0020$^\bullet$	.0046$^\bullet$	.0197$^\bullet$	.0018$^\bullet$	.0236$^\bullet$	.0122$^\bullet$
$TSP(2000,c)$	short	.0019$^\bullet$	.0074$^\bullet$	.0062$^\bullet$	.0029$^\bullet$	.0110$^\bullet$	.0061$^\bullet$
$TSP(2000,x)$	short	.0024$^\bullet$	.0120$^\bullet$	.0041$^\bullet$	.0021$^\bullet$	.0081$^\bullet$	.0078$^\bullet$
$TSP(x,u)$	short	.0008$^\bullet$	.0036$^\bullet$	.0201$^\bullet$	.0017$^\bullet$	.0227$^\bullet$	.0103$^\bullet$
$TSP(x,c)$	short	.0011	.0064$^\bullet$	.0033$^\bullet$	.0011	.0114$^\bullet$	.0044$^\bullet$
$TSP(x,x)$	short	.0020$^\bullet$	.0086$^\bullet$	.0020$^\bullet$	.0007	.0069$^\bullet$	.0051$^\bullet$
$TSP(2000,u)$	long	.0012$^\bullet$	.0022$^\bullet$	.0051$^\bullet$	.0004	.0230$^\bullet$	.0126$^\bullet$
SAa							
$TSP(2000,u)$	short	.0060$^\bullet$	.0085$^\bullet$		.0177$^\bullet$	.0068$^\bullet$	
$TSP(2000,c)$	short	.0108$^\bullet$	.0136$^\bullet$		.0104$^\bullet$	.0106$^\bullet$	
$TSP(2000,x)$	short	.0082$^\bullet$	.0103$^\bullet$		.0069$^\bullet$	.0063$^\bullet$	
$TSP(x,u)$	short	.0044$^\bullet$	.0060$^\bullet$		.0152$^\bullet$	.0054$^\bullet$	
$TSP(x,c)$	short	.0078$^\bullet$	.0079$^\bullet$		.0066$^\bullet$	.0062$^\bullet$	
$TSP(x,x)$	short	.0063$^\bullet$	.0068$^\bullet$		.0062$^\bullet$	.0053$^\bullet$	
$TSP(2000,u)$	long	.0016$^\bullet$	.0043$^\bullet$		.0124$^\bullet$	.0031$^\bullet$	
LS							
$TSP(2000,u)$	short	.0060$^\bullet$	.0085$^\bullet$		.0177$^\bullet$	.0068$^\bullet$	
$TSP(2000,c)$	short	.0108$^\bullet$	.0136$^\bullet$		.0104$^\bullet$	.0106$^\bullet$	
$TSP(2000,x)$	short	.0082$^\bullet$	.0103$^\bullet$		.0069$^\bullet$	.0063$^\bullet$	
$TSP(x,u)$	short	.0044$^\bullet$	.0060$^\bullet$		.0152$^\bullet$	.0054$^\bullet$	
$TSP(x,c)$	short	.0078$^\bullet$	.0079$^\bullet$		.0066$^\bullet$	.0062$^\bullet$	
$TSP(x,x)$	short	.0063$^\bullet$	.0068$^\bullet$		.0062$^\bullet$	.0053$^\bullet$	
$TSP(2000,u)$	long	.0016$^\bullet$	.0043$^\bullet$		.0124$^\bullet$	.0031$^\bullet$	



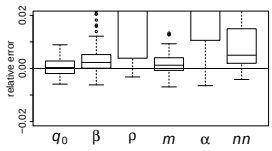
(a) TSP set $TSP(2000, u)$ short run



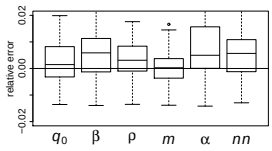
(b) TSP set $TSP(2000, c)$ short run



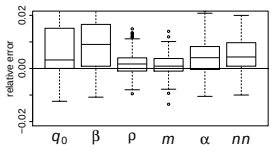
(c) TSP set $TSP(2000, x)$ short run



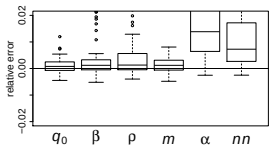
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

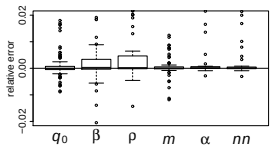


(f) TSP set $TSP(x, x)$ short run

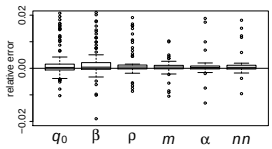


(g) TSP set $TSP(2000, u)$ long run

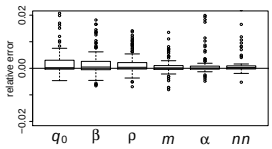
Fig. 1: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAc



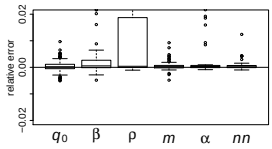
(a) TSP set $TSP(2000, u)$ short run



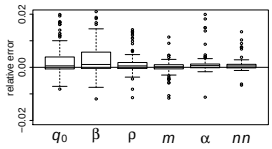
(b) TSP set $TSP(2000, c)$ short run



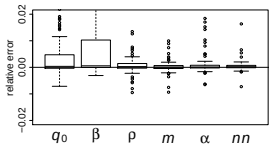
(c) TSP set $TSP(2000, x)$ short run



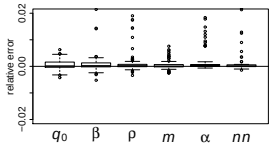
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

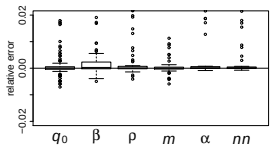


(f) TSP set $TSP(x, x)$ short run

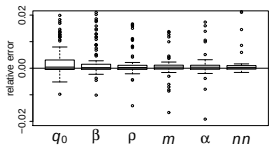


(g) TSP set $TSP(2000, u)$ long run

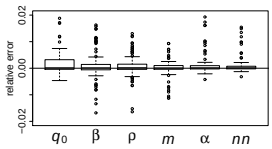
Fig. 2: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: SAc



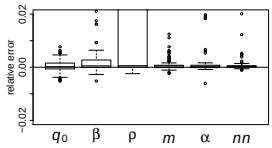
(a) TSP set $TSP(2000, u)$ short run



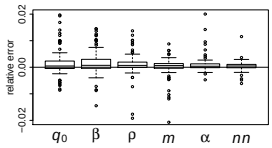
(b) TSP set $TSP(2000, c)$ short run



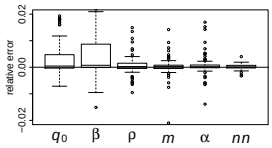
(c) TSP set $TSP(2000, x)$ short run



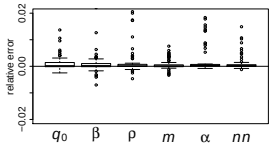
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

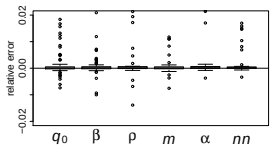


(f) TSP set $TSP(x, x)$ short run

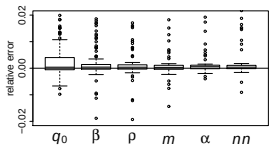


(g) TSP set $TSP(2000, u)$ long run

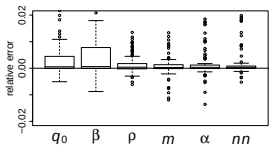
Fig. 3: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: SAc



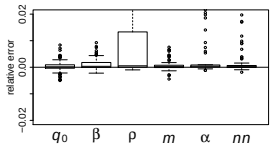
(a) TSP set $TSP(2000, u)$ short run



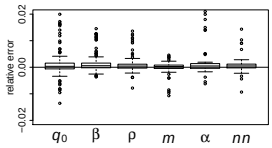
(b) TSP set $TSP(2000, c)$ short run



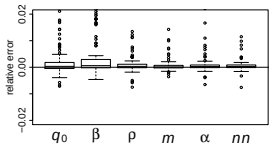
(c) TSP set $TSP(2000, x)$ short run



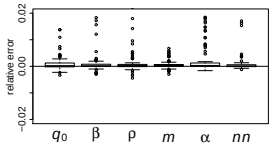
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

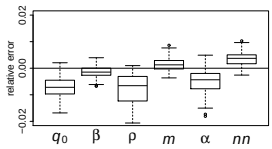


(f) TSP set $TSP(x, x)$ short run

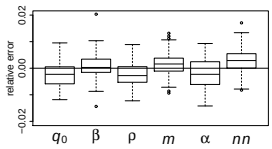


(g) TSP set $TSP(2000, u)$ long run

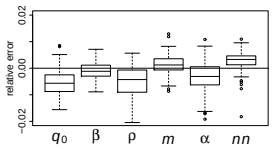
Fig. 4: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: SAc



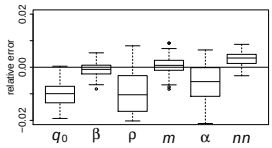
(a) TSP set $TSP(2000, u)$ short run



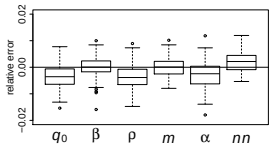
(b) TSP set $TSP(2000, c)$ short run



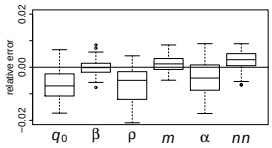
(c) TSP set $TSP(2000, x)$ short run



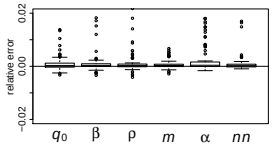
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

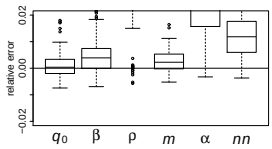


(f) TSP set $TSP(x, x)$ short run

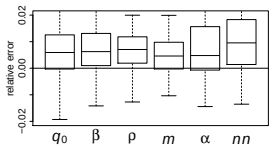


(g) TSP set $TSP(2000, u)$ long run

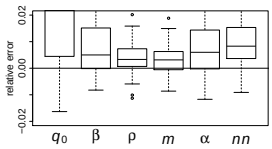
Fig. 5: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAc



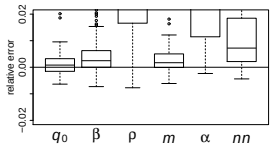
(a) TSP set $TSP(2000, u)$ short run



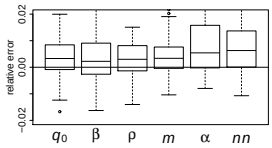
(b) TSP set $TSP(2000, c)$ short run



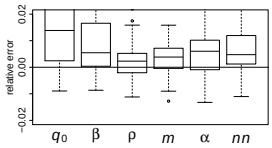
(c) TSP set $TSP(2000, x)$ short run



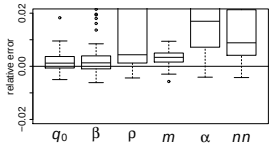
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

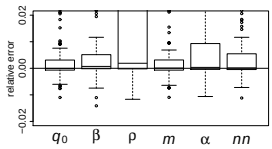


(f) TSP set $TSP(x, x)$ short run

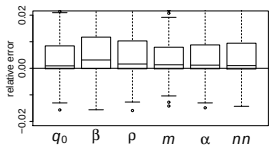


(g) TSP set $TSP(2000, u)$ long run

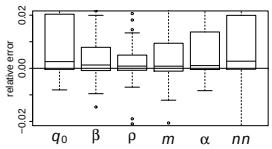
Fig. 6: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAcb



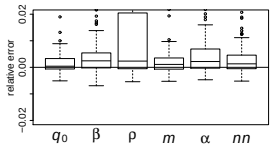
(a) TSP set $TSP(2000, u)$ short run



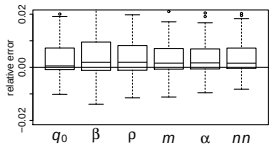
(b) TSP set $TSP(2000, c)$ short run



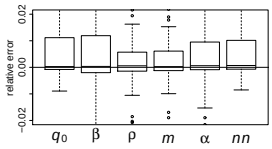
(c) TSP set $TSP(2000, x)$ short run



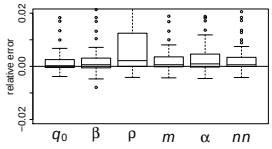
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

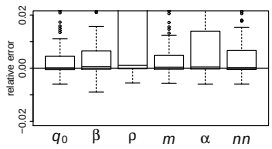


(f) TSP set $TSP(x, x)$ short run

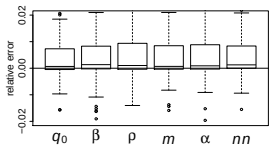


(g) TSP set $TSP(2000, u)$ long run

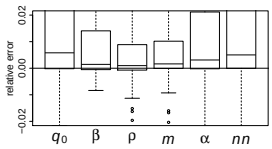
Fig. 7: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: SAcb



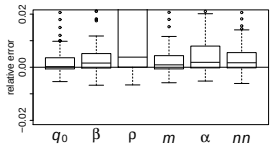
(a) TSP set $TSP(2000, u)$ short run



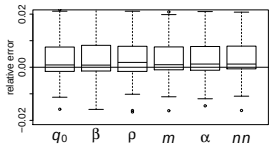
(b) TSP set $TSP(2000, c)$ short run



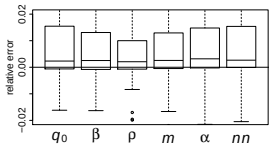
(c) TSP set $TSP(2000, x)$ short run



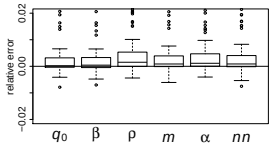
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

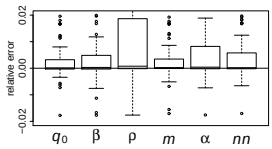


(f) TSP set $TSP(x, x)$ short run

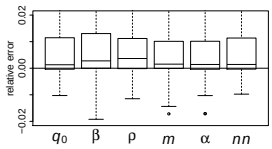


(g) TSP set $TSP(2000, u)$ long run

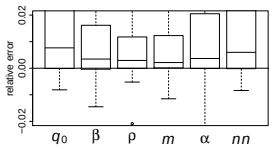
Fig. 8: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: SAcb



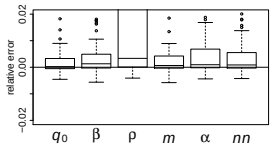
(a) TSP set $TSP(2000, u)$ short run



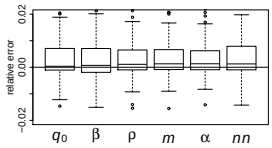
(b) TSP set $TSP(2000, c)$ short run



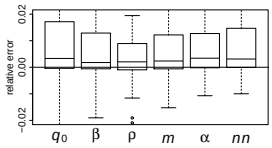
(c) TSP set $TSP(2000, x)$ short run



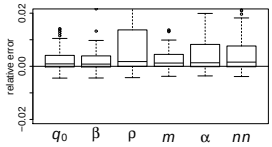
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

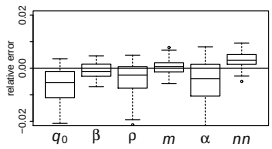


(f) TSP set $TSP(x, x)$ short run

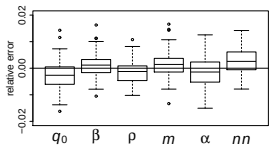


(g) TSP set $TSP(2000, u)$ long run

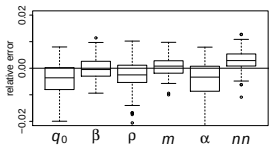
Fig. 9: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: SAcb



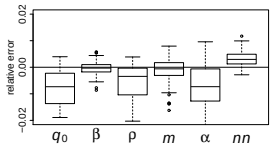
(a) TSP set $TSP(2000, u)$ short run



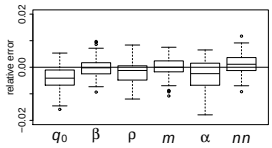
(b) TSP set $TSP(2000, c)$ short run



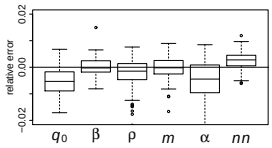
(c) TSP set $TSP(2000, x)$ short run



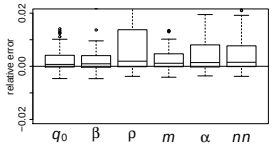
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

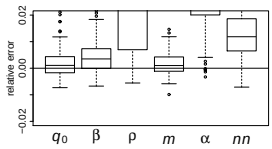


(f) TSP set $TSP(x, x)$ short run

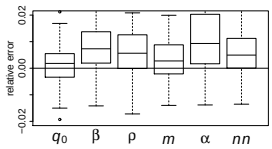


(g) TSP set $TSP(2000, u)$ long run

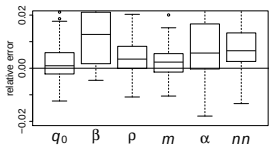
Fig. 10: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAcb



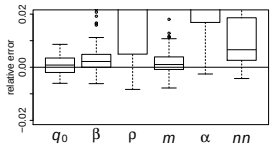
(a) TSP set $TSP(2000, u)$ short run



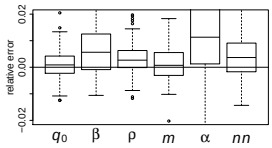
(b) TSP set $TSP(2000, c)$ short run



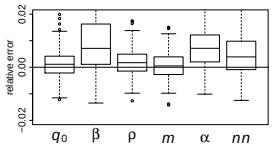
(c) TSP set $TSP(2000, x)$ short run



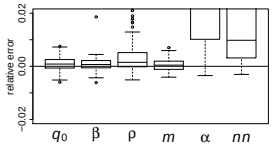
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

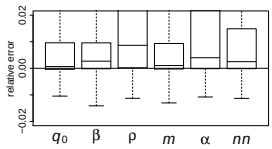


(f) TSP set $TSP(x, x)$ short run

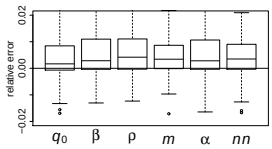


(g) TSP set $TSP(2000, u)$ long run

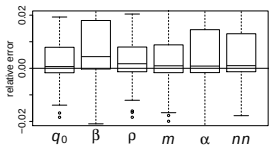
Fig. 11: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAcm



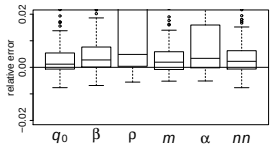
(a) TSP set $TSP(2000, u)$ short run



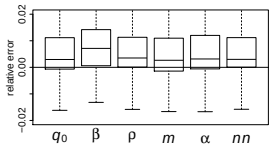
(b) TSP set $TSP(2000, c)$ short run



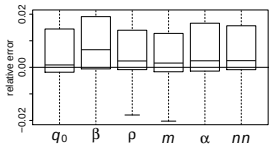
(c) TSP set $TSP(2000, x)$ short run



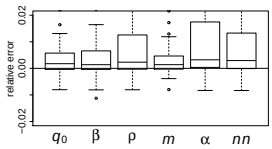
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

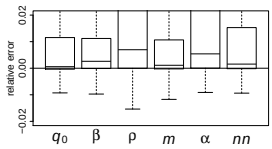


(f) TSP set $TSP(x, x)$ short run

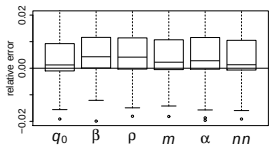


(g) TSP set $TSP(2000, u)$ long run

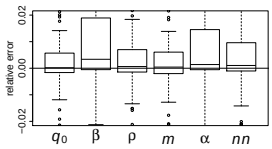
Fig. 12: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: SAcm



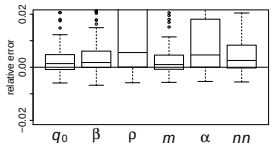
(a) TSP set $TSP(2000, u)$ short run



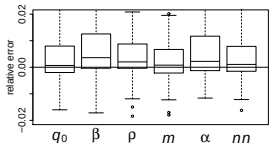
(b) TSP set $TSP(2000, c)$ short run



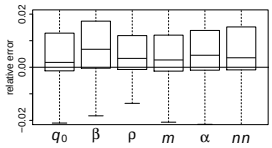
(c) TSP set $TSP(2000, x)$ short run



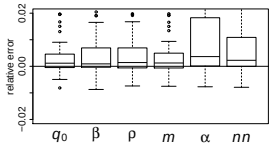
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

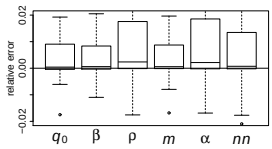


(f) TSP set $TSP(x, x)$ short run

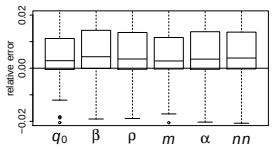


(g) TSP set $TSP(2000, u)$ long run

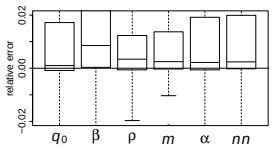
Fig. 13: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: SAcm



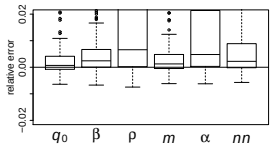
(a) TSP set $TSP(2000, u)$ short run



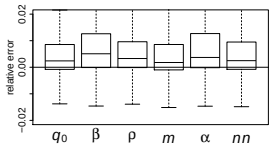
(b) TSP set $TSP(2000, c)$ short run



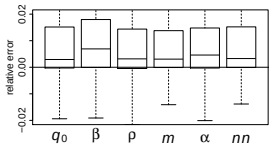
(c) TSP set $TSP(2000, x)$ short run



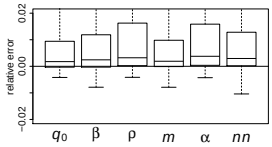
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

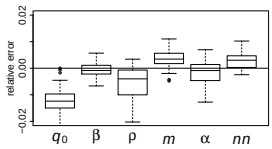


(f) TSP set $TSP(x, x)$ short run

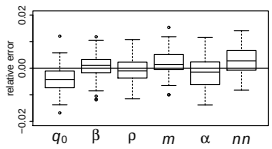


(g) TSP set $TSP(2000, u)$ long run

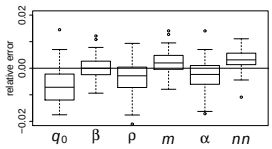
Fig. 14: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: SAcm



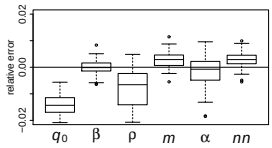
(a) TSP set $TSP(2000, u)$ short run



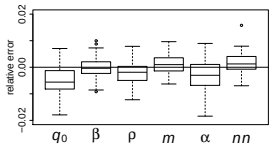
(b) TSP set $TSP(2000, c)$ short run



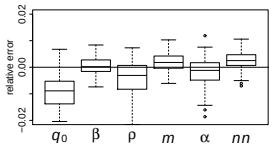
(c) TSP set $TSP(2000, x)$ short run



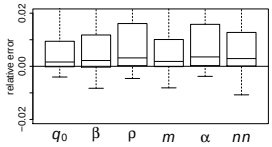
(d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run

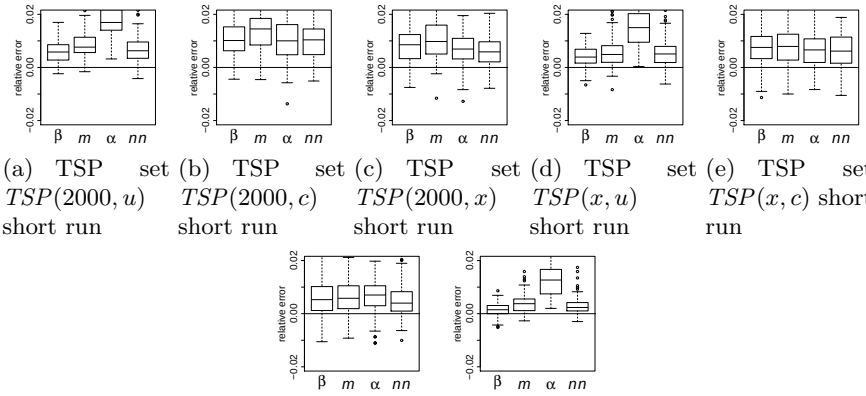


(f) TSP set $TSP(x, x)$ short run



(g) TSP set $TSP(2000, u)$ long run

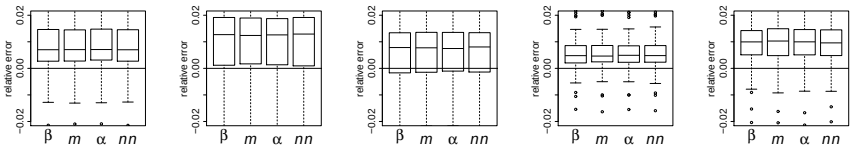
Fig. 15: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAcm



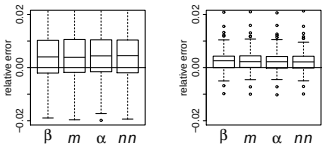
(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run

(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 16: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAa

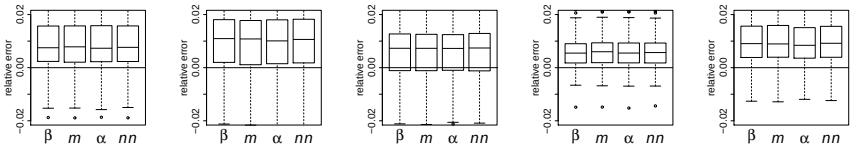


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run

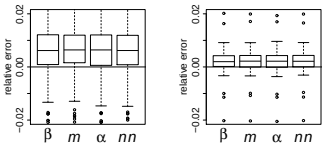


(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 17: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: SAa

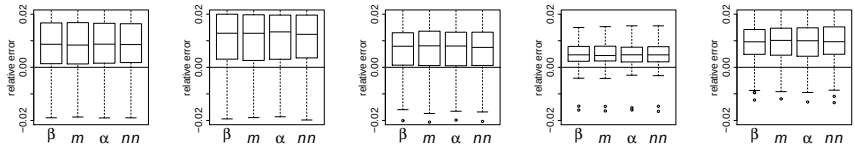


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run

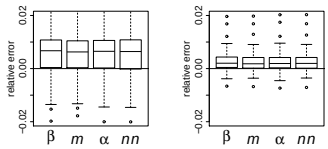


(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 18: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: SAa

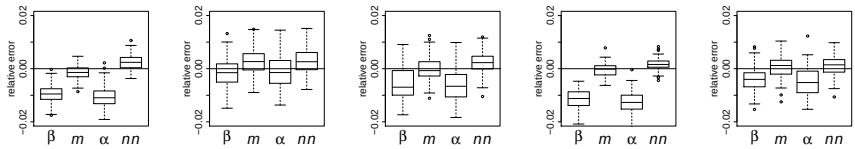


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run

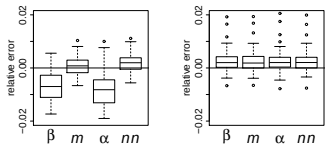


(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 19: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: SAa

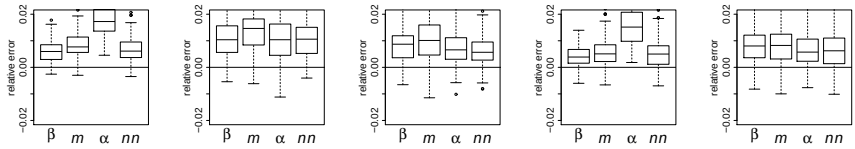


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run

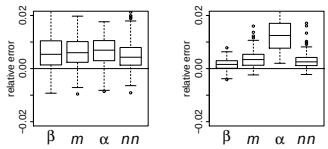


(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 20: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAa

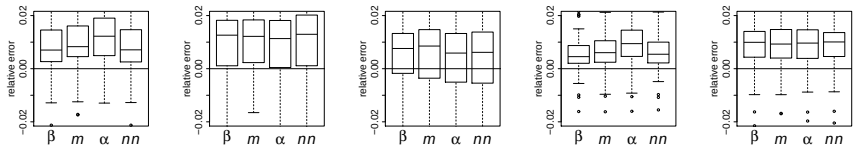


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run

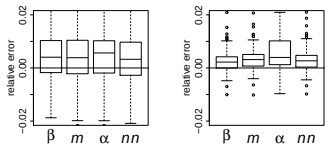


(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 21: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: LS

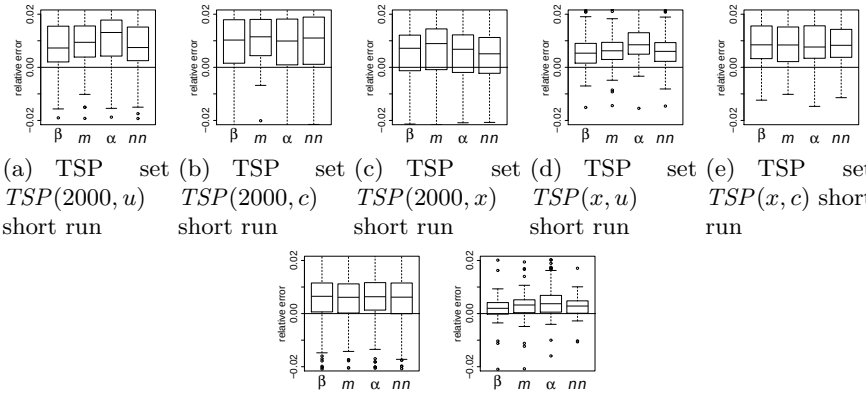


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run



(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

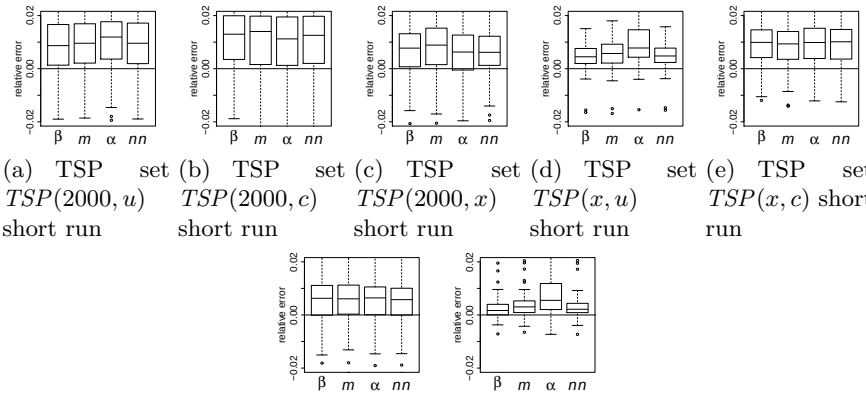
Fig. 22: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: LS



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run

(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

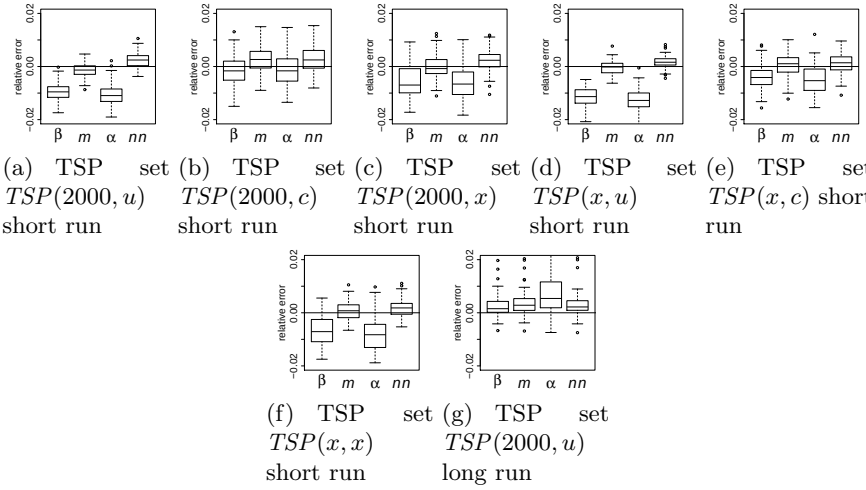
Fig. 23: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: LS



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run

(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

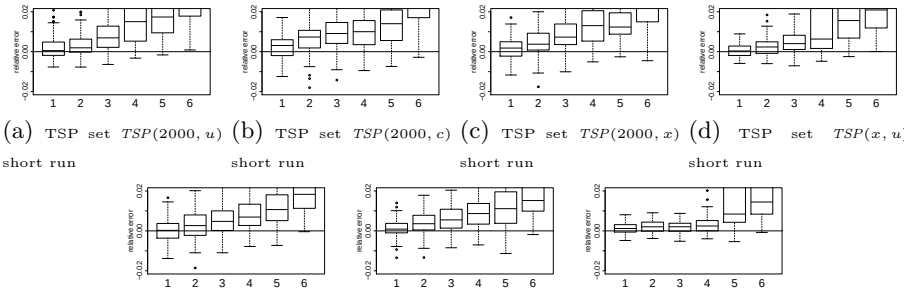
Fig. 24: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: LS



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run

(f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

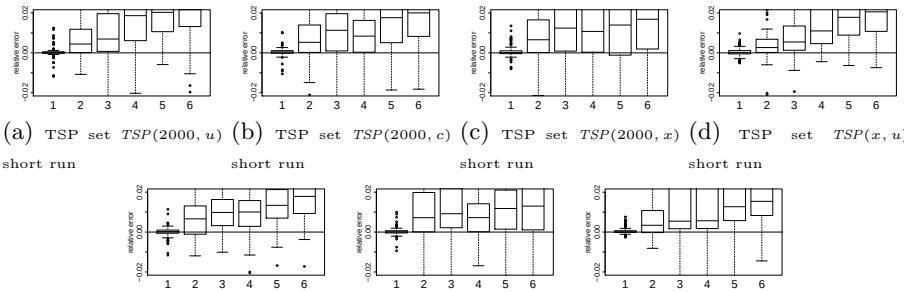
Fig. 25: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: LS



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 26: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAc



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 27: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: SAc

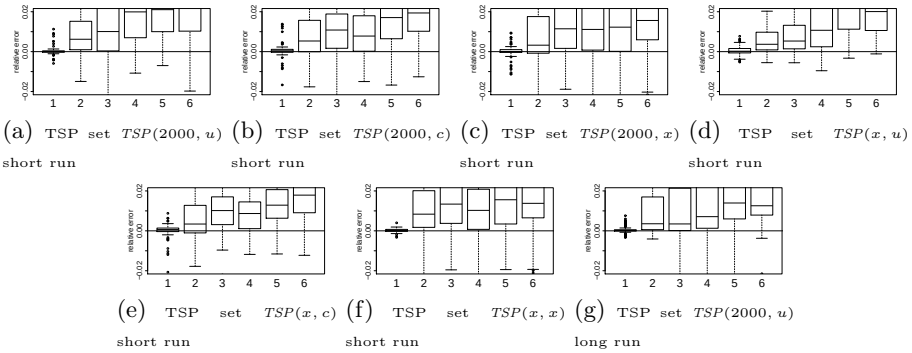


Fig. 28: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: SAc

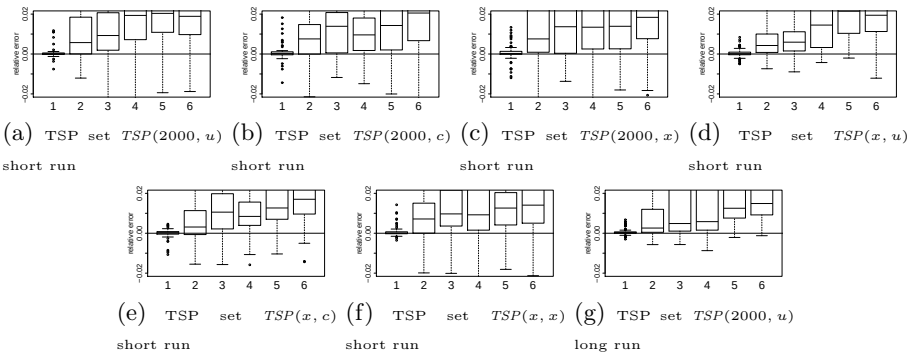
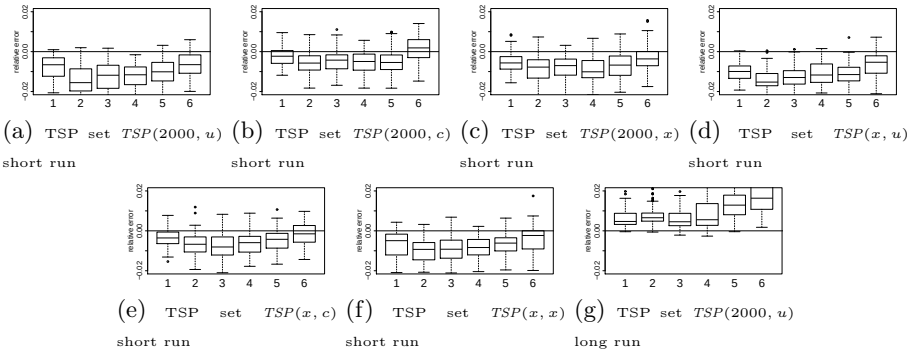


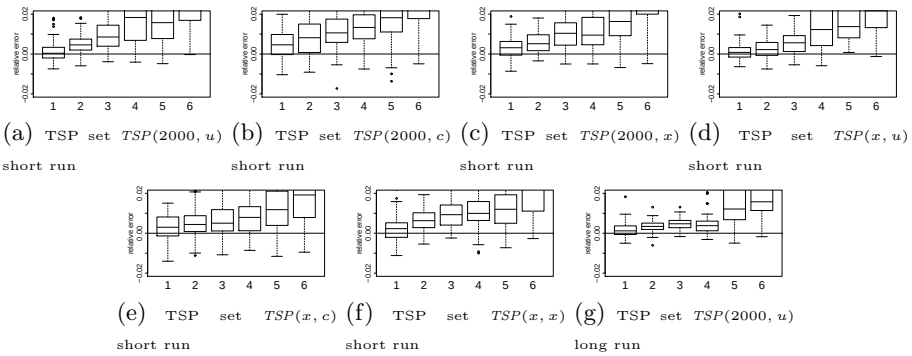
Fig. 29: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: SAc



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

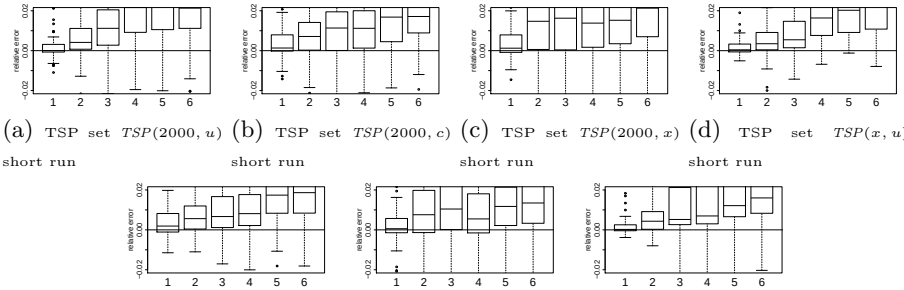
Fig. 30: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAc



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

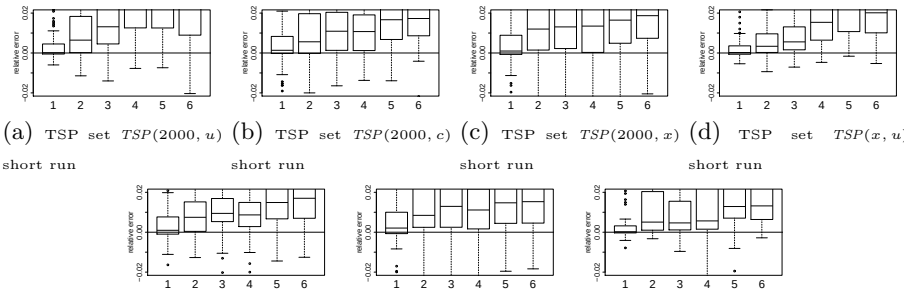
Fig. 31: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAcb



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

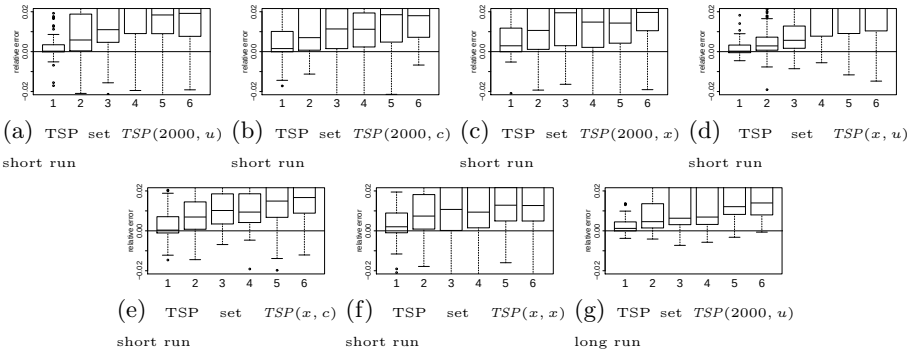
Fig. 32: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: SAcb



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

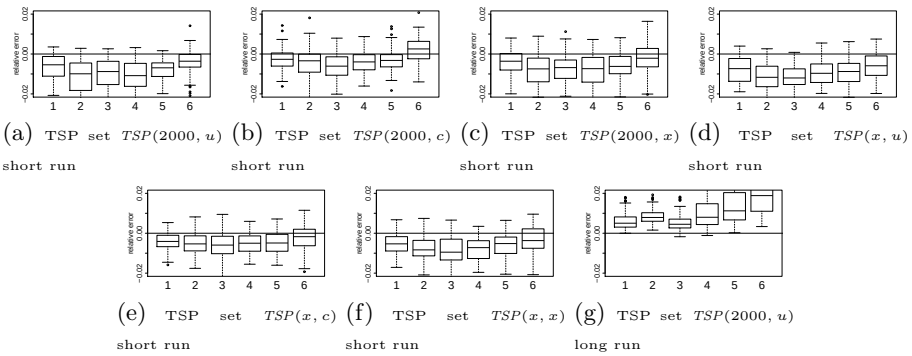
Fig. 33: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: SAcb



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

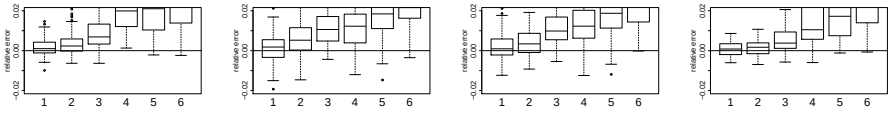
Fig. 34: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: SAcb



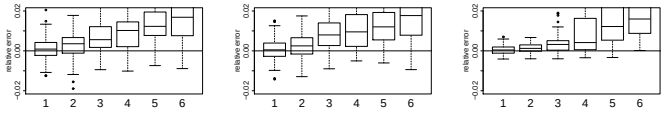
(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 35: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAcb

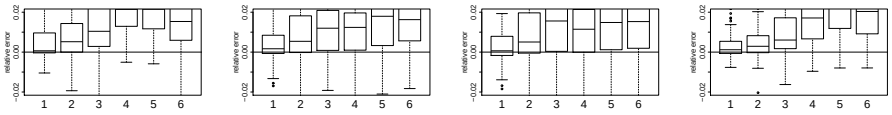


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

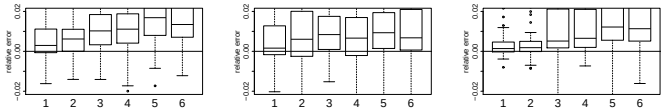


(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 36: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAcm



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run



(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

Fig. 37: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: SAcm

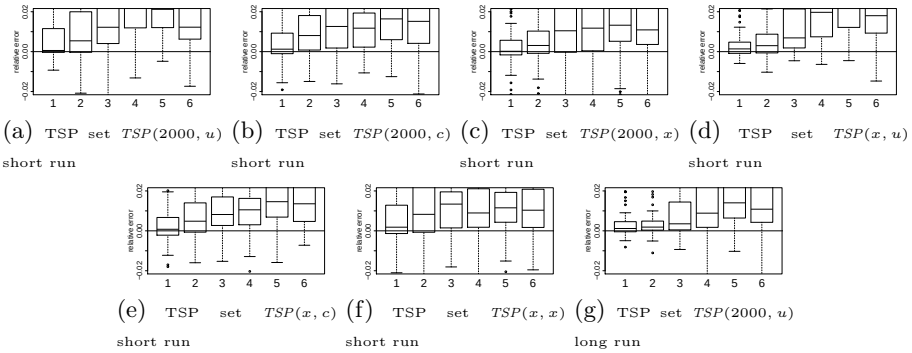


Fig. 38: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: SAcm

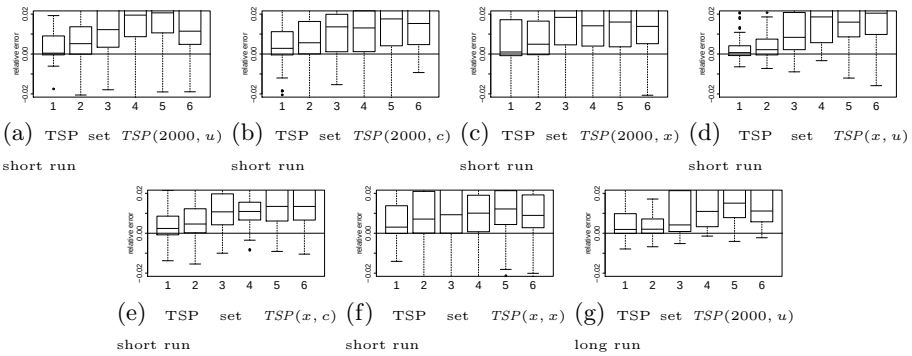
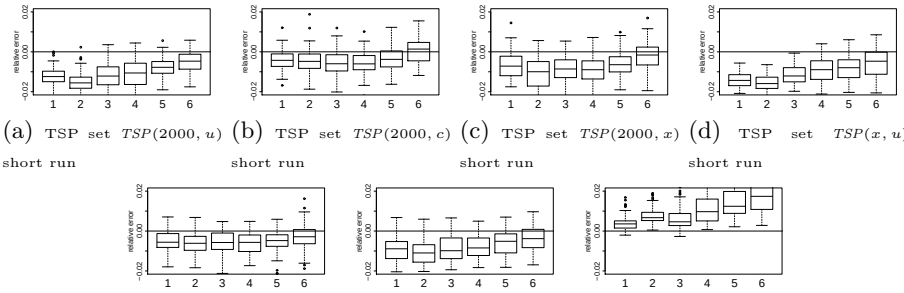


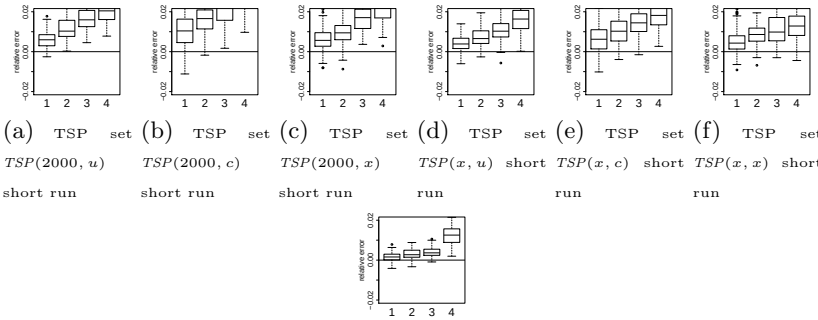
Fig. 39: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: SAcm



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run

(e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run (g) TSP set $TSP(2000, u)$ long run

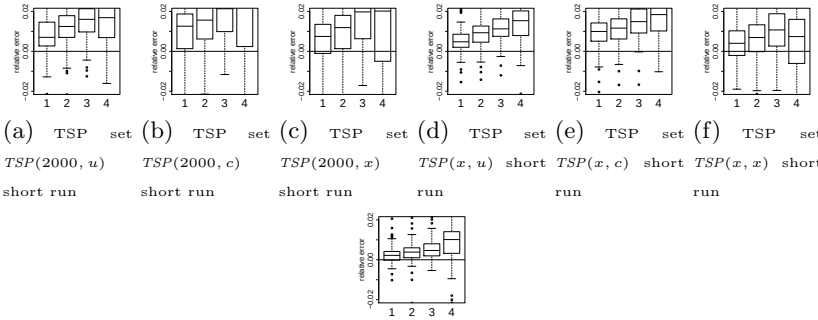
Fig. 40: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAcm



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run

(g) TSP set $TSP(2000, u)$ long run

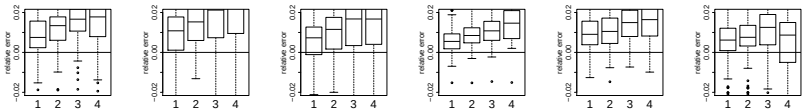
Fig. 41: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAa



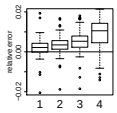
(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run

(g) TSP set $TSP(2000, u)$ long run

Fig. 42: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: SAa

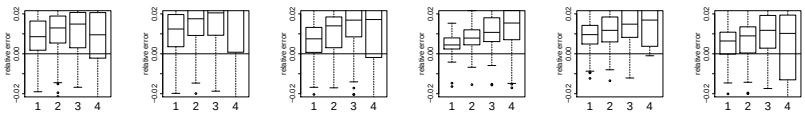


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run

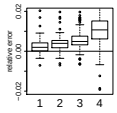


(g) TSP set $TSP(2000, u)$ long run

Fig. 43: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: SAa

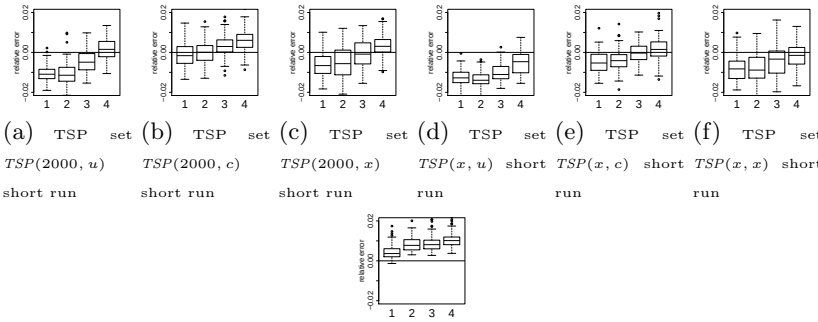


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run



(g) TSP set $TSP(2000, u)$ long run

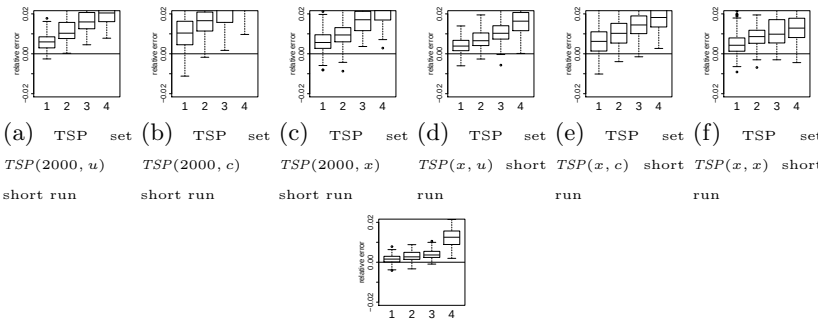
Fig. 44: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: SAa



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run

(g) TSP set $TSP(2000, u)$ long run

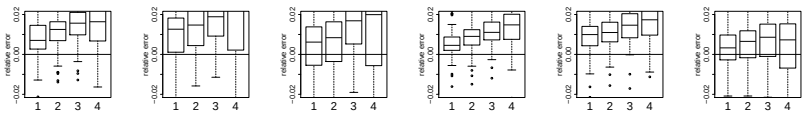
Fig. 45: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAa



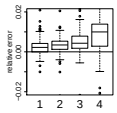
(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run

(g) TSP set $TSP(2000, u)$ long run

Fig. 46: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: LS

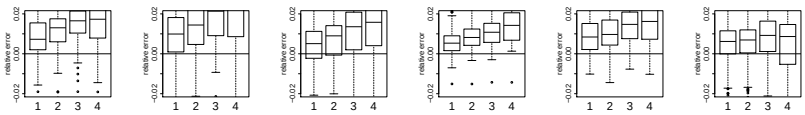


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run

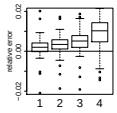


(g) TSP set $TSP(2000, u)$ long run

Fig. 47: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-high tuning effort. Adaptation method: LS

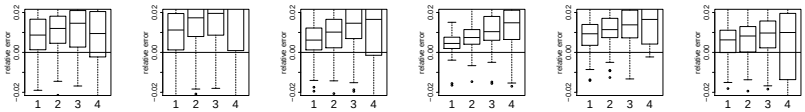


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run

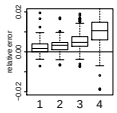


(g) TSP set $TSP(2000, u)$ long run

Fig. 48: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with medium-low tuning effort. Adaptation method: LS

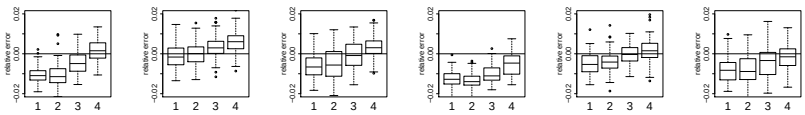


(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run

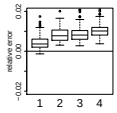


(g) TSP set $TSP(2000, u)$ long run

Fig. 49: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with low tuning effort. Adaptation method: LS



(a) TSP set $TSP(2000, u)$ short run (b) TSP set $TSP(2000, c)$ short run (c) TSP set $TSP(2000, x)$ short run (d) TSP set $TSP(x, u)$ short run (e) TSP set $TSP(x, c)$ short run (f) TSP set $TSP(x, x)$ short run



(g) TSP set $TSP(2000, u)$ long run

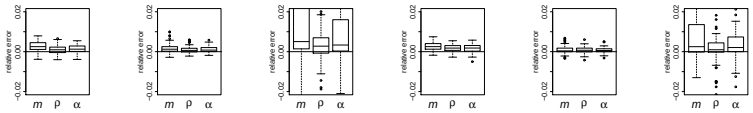
Fig. 50: TSP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: LS

Table 5: Average relative error for each set of instances of the **QAP**. Comparison between $\mathcal{MM}$AS applying the five parameter adaptation methods and applying no adaptation. Results obtained adapting each single parameter. A bullet following the value indicates that no adaptation is statistically better than adaptation. A star indicates that no adaptation is statistically worse than adaptation.

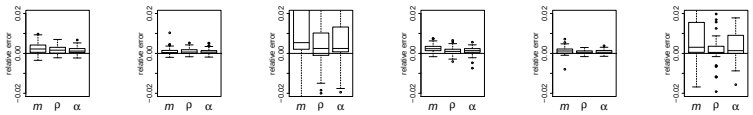
		Setting of non-adapted parameters: **literature**			Setting of non-adapted parameters: **high tuning effort**		
instance set	runs	m	ρ	α	m	ρ	α
SAc							
$QAP(80, RR)$	short	.0016$^\bullet$	.0024$^\bullet$	.0007$^\bullet$	.0026$^\bullet$	.0010$^\bullet$	.0013$^\bullet$
$QAP(80, ES)$	short	.0033$^\bullet$	.0035$^\bullet$	.0026$^\bullet$	.0018$^\bullet$	.0009$^\bullet$	.0011$^\bullet$
$QAP(80, x)$	short	.0185$^\bullet$	.0217$^\bullet$	.0126$^\bullet$	.0242$^\bullet$	.0029$^\bullet$	.0102$^\bullet$
$QAP(x, RR)$	short	.0035$^\bullet$	.0020$^\bullet$	.0013$^\bullet$	.0027$^\bullet$	.0017$^\bullet$	.0017$^\bullet$
$QAP(x, ES)$	short	.0030$^\bullet$	.0028$^\bullet$	.0022$^\bullet$	.0010$^\bullet$	.0008$^\bullet$	.0008$^\bullet$
$QAP(x, x)$	short	.0154$^\bullet$	.0094$^\bullet$	.0070$^\bullet$	.0188$^\bullet$	.0053$^\bullet$	.0082$^\bullet$
SAcb							
$QAP(80, RR)$	short	.0017$^\bullet$	.0016$^\bullet$	.0004$^\bullet$	.0022$^\bullet$	.0008$^\bullet$	.0013$^\bullet$
$QAP(80, ES)$	short	.0033$^\bullet$	.0031$^\bullet$	.0018$^\bullet$	.0011$^\bullet$	.0007$^\bullet$	.0015$^\bullet$
$QAP(80, x)$	short	.0186$^\bullet$	.0087$^\bullet$	.0077$^\bullet$	.0201$^\bullet$	.0079$^\bullet$	.0113$^\bullet$
$QAP(x, RR)$	short	.0030$^\bullet$	.0018$^\bullet$	.0014$^\bullet$	.0028$^\bullet$	.0015$^\bullet$	.0016$^\bullet$
$QAP(x, ES)$	short	.0030$^\bullet$	.0027$^\bullet$	.0019$^\bullet$	.0009$^\bullet$	.0006$^\bullet$	.0011$^\bullet$
$QAP(x, x)$	short	.0189$^\bullet$	.0079$^\bullet$	.0082$^\bullet$	.0187$^\bullet$	.0061$^\bullet$	.0072$^\bullet$
SAcm							
$QAP(80, RR)$	short	.0016$^\bullet$	.0036$^\bullet$	.0006$^\bullet$	.0024$^\bullet$	.0011$^\bullet$	.0010$^\bullet$
$QAP(80, ES)$	short	.0031$^\bullet$	.0038$^\bullet$	.0023$^\bullet$	.0012$^\bullet$	.0009$^\bullet$	.0013$^\bullet$
$QAP(80, x)$	short	.0248$^\bullet$	.0252$^\bullet$	.0103$^\bullet$	.0252$^\bullet$	.0057$^\bullet$	.0104$^\bullet$
$QAP(x, RR)$	short	.0027$^\bullet$	.0016$^\bullet$	.0016$^\bullet$	.0027$^\bullet$	.0016$^\bullet$	.0013$^\bullet$
$QAP(x, ES)$	short	.0028$^\bullet$	.0036$^\bullet$	.0021$^\bullet$	.0009$^\bullet$	.0011$^\bullet$	.0012$^\bullet$
$QAP(x, x)$	short	.0178$^\bullet$	.0122$^\bullet$	.0065$^\bullet$	.0224$^\bullet$	.0055$^\bullet$	.0077$^\bullet$
SAa							
$QAP(80, RR)$	short			.0020$^\bullet$			.0033$^\bullet$
$QAP(80, ES)$	short			.0045$^\bullet$			.0010$^\bullet$
$QAP(80, x)$	short			.0228$^\bullet$			.0341$^\bullet$
$QAP(x, RR)$	short			.0031$^\bullet$			.0041$^\bullet$
$QAP(x, ES)$	short			.0042$^\bullet$			.0007$^\bullet$
$QAP(x, x)$	short			.0135$^\bullet$			.0226$^\bullet$
LS							
$QAP(80, RR)$	short			.0020$^\bullet$			.0061$^\bullet$
$QAP(80, ES)$	short			.0103$^\bullet$			.0084$^\bullet$
$QAP(80, x)$	short			.0495$^\bullet$			.0490$^\bullet$
$QAP(x, RR)$	short			.0031$^\bullet$			.0064$^\bullet$
$QAP(x, ES)$	short			.0098$^\bullet$			.0085$^\bullet$
$QAP(x, x)$	short			.0595$^\bullet$			.0585$^\bullet$

Table 6: Average relative error for each set of instances of the **QAP**. Comparison between $\mathcal{MM}$AS applying the five parameter adaptation methods and applying no adaptation. Results obtained adapting each single parameter. A bullet following the value indicates that no adaptation is statistically better than adaptation. A star indicates that no adaptation is statistically worse than adaptation.

		Setting of non-adapted parameters: **literature**			Setting of non-adapted parameters: **high tuning effort**		
instance set	runs	m	ρ	α	m	ρ	α
SAc							
$QAP(80, RR)$	long	$.0022^{\bullet}$	$.0023^{\bullet}$	$.0014^{\bullet}$	$.0026^{\bullet}$	$.0017^{\bullet}$	$.0014^{\bullet}$
$QAP(80, ES)$	long	$.0016^{\bullet}$	$.0012^{\bullet}$	$.0009^{\bullet}$	$.0008^{\bullet}$	$.0010^{\bullet}$	$.0009^{\bullet}$
$QAP(80, x)$	long	$.0184^{\bullet}$	$.0065^{\bullet}$	$.0114^{\bullet}$	$.0221^{\bullet}$	$.0084^{\bullet}$	$.0101^{\bullet}$
$QAP(x, RR)$	long	$.0030^{\bullet}$	$.0018^{\bullet}$	$.0017^{\bullet}$	$.0025^{\bullet}$	$.0011^{\bullet}$	$.0014^{\bullet}$
$QAP(x, ES)$	long	$.0005^{\bullet}$	$.0005^{\bullet}$	$.0006^{\bullet}$	$.0012^{\bullet}$	$.0006^{\bullet}$	$.0008^{\bullet}$
$QAP(x, x)$	long	$.0208^{\bullet}$	$.0064^{\bullet}$	$.0088^{\bullet}$	$.0175^{\bullet}$	$.0031^{\bullet}$	$.0070^{\bullet}$
SAcb							
$QAP(80, RR)$	long	$.0018^{\bullet}$	$.0017^{\bullet}$	$.0010^{\bullet}$	$.0024^{\bullet}$	$.0009^{\bullet}$	$.0010^{\bullet}$
$QAP(80, ES)$	long	$.0016^{\bullet}$	$.0012^{\bullet}$	$.0009^{\bullet}$	$.0010^{\bullet}$	$.0010^{\bullet}$	$.0009^{\bullet}$
$QAP(80, x)$	long	$.0172^{\bullet}$	$.0088^{\bullet}$	$.0122^{\bullet}$	$.0256^{\bullet}$	$.0059^{\bullet}$	$.0081^{\bullet}$
$QAP(x, RR)$	long	$.0030^{\bullet}$	$.0013^{\bullet}$	$.0008^{\bullet}$	$.0028^{\bullet}$	$.0011^{\bullet}$	$.0013^{\bullet}$
$QAP(x, ES)$	long	$.0007^{\bullet}$	$.0009^{\bullet}$	$.0008^{\bullet}$	$.0011^{\bullet}$	$.0006^{\bullet}$	$.0010^{\bullet}$
$QAP(x, x)$	long	$.0140^{\bullet}$	$.0067^{\bullet}$	$.0092^{\bullet}$	$.0168^{\bullet}$	$.0041^{\bullet}$	$.0044^{\bullet}$
SAcm							
$QAP(80, RR)$	long	$.0016^{\bullet}$	$.0026^{\bullet}$	$.0013^{\bullet}$	$.0022^{\bullet}$	$.0013^{\bullet}$	$.0014^{\bullet}$
$QAP(80, ES)$	long	$.0013^{\bullet}$	$.0015^{\bullet}$	$.0010^{\bullet}$	$.0008^{\bullet}$	$.0010^{\bullet}$	$.0009^{\bullet}$
$QAP(80, x)$	long	$.0164^{\bullet}$	$.0074^{\bullet}$	$.0126^{\bullet}$	$.0241^{\bullet}$	$.0081^{\bullet}$	$.0090^{\bullet}$
$QAP(x, RR)$	long	$.0028^{\bullet}$	$.0014^{\bullet}$	$.0014^{\bullet}$	$.0027^{\bullet}$	$.0013^{\bullet}$	$.0011^{\bullet}$
$QAP(x, ES)$	long	$.0008^{\bullet}$	$.0010^{\bullet}$	$.0007^{\bullet}$	$.0011^{\bullet}$	$.0007^{\bullet}$	$.0008^{\bullet}$
$QAP(x, x)$	long	$.0148^{\bullet}$	$.0082^{\bullet}$	$.0099^{\bullet}$	$.0165^{\bullet}$	$.0067^{\bullet}$	$.0071^{\bullet}$
SAa							
$QAP(80, RR)$	long			$.0021^{\bullet}$			$.0036^{\bullet}$
$QAP(80, ES)$	long			$.0012^{\bullet}$			$.0007^{\bullet}$
$QAP(80, x)$	long			$.0162^{\bullet}$			$.0251^{\bullet}$
$QAP(x, RR)$	long			$.0028^{\bullet}$			$.0038^{\bullet}$
$QAP(x, ES)$	long			$.0012^{\bullet}$			$.0011^{\bullet}$
$QAP(x, x)$	long			$.0123^{\bullet}$			$.0216^{\bullet}$
LS							
$QAP(80, RR)$	long			$.0021^{\bullet}$			$.0065^{\bullet}$
$QAP(80, ES)$	long			$.0064^{\bullet}$			$.0076^{\bullet}$
$QAP(80, x)$	long			$.0414^{\bullet}$			$.0493^{\bullet}$
$QAP(x, RR)$	long			$.0028^{\bullet}$			$.0065^{\bullet}$
$QAP(x, ES)$	long			$.0051^{\bullet}$			$.0080^{\bullet}$
$QAP(x, x)$	long			$.0597^{\bullet}$			$.0588^{\bullet}$

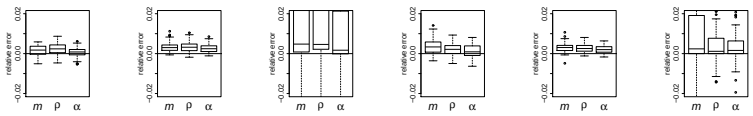


(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

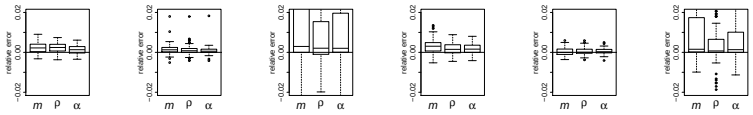


(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

Fig. 51: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAc

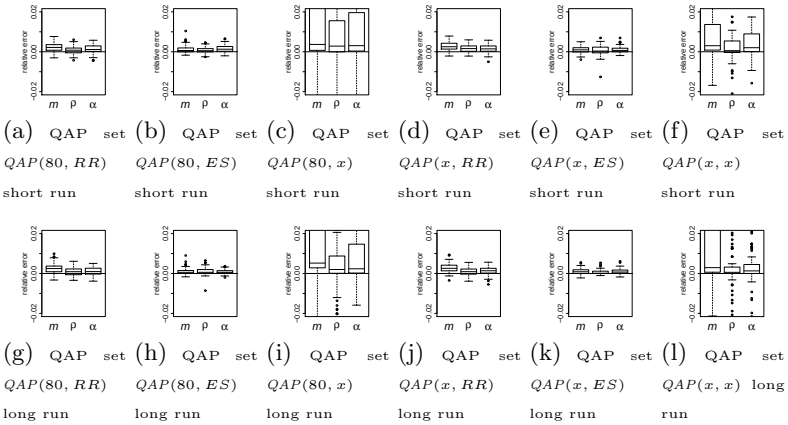


(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run



(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

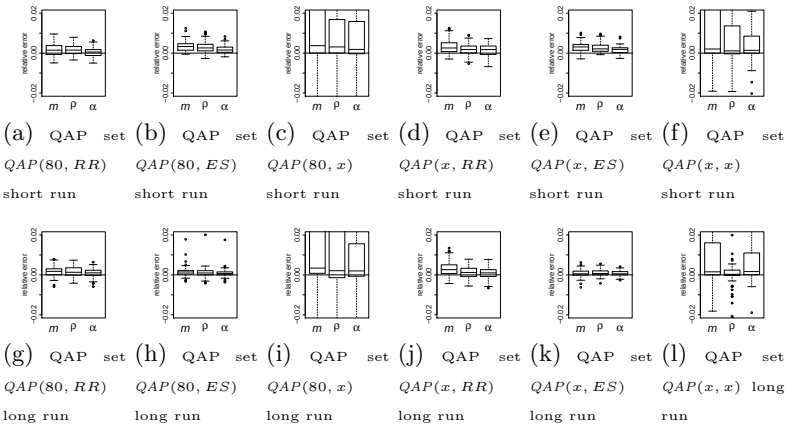
Fig. 52: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAc



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

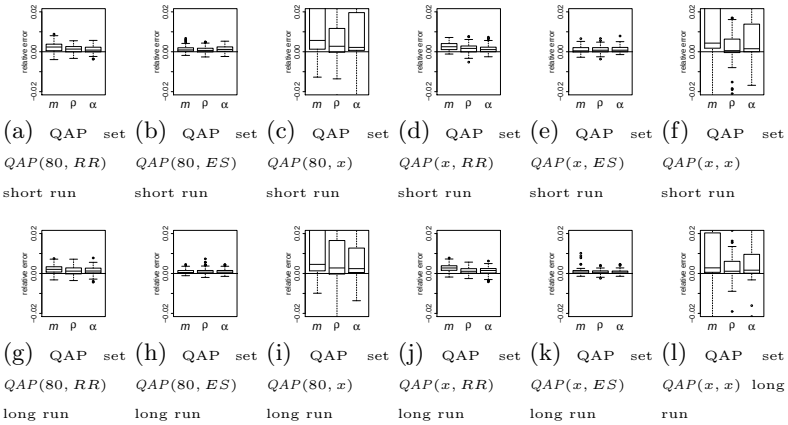
Fig. 53: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAcb



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

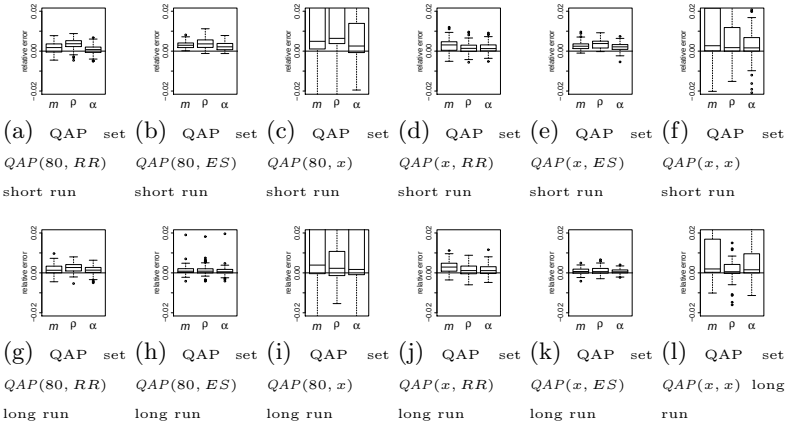
Fig. 54: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAcb



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

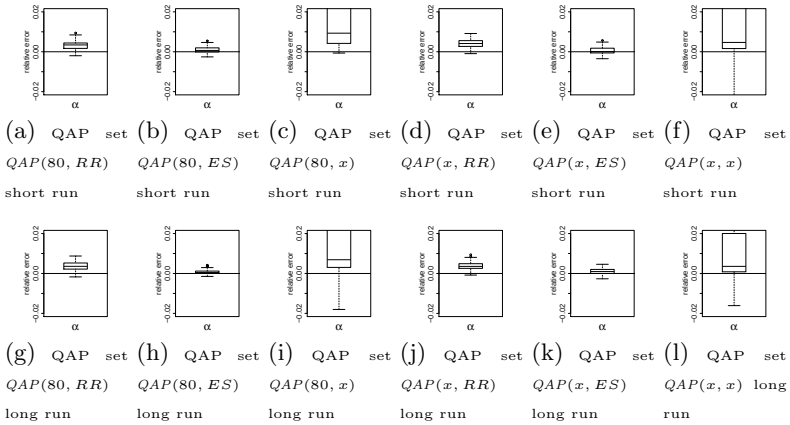
Fig. 55: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAcm



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

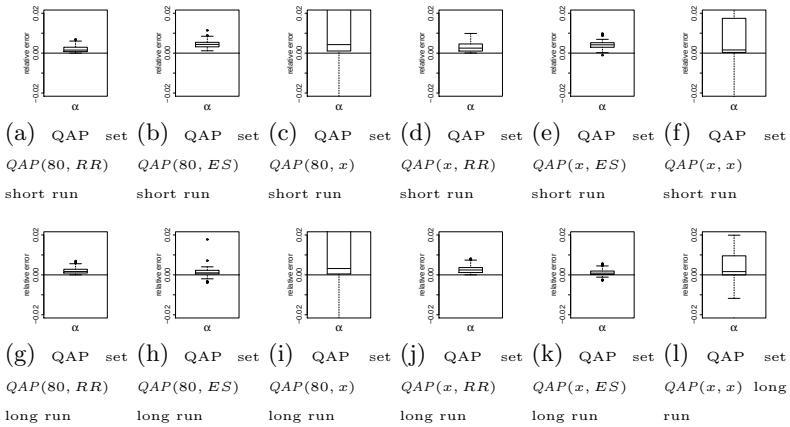
Fig. 56: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAcm



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

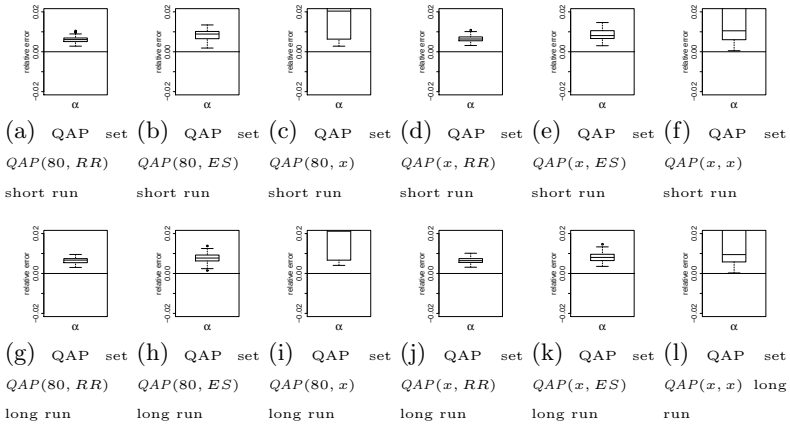
Fig. 57: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAa



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

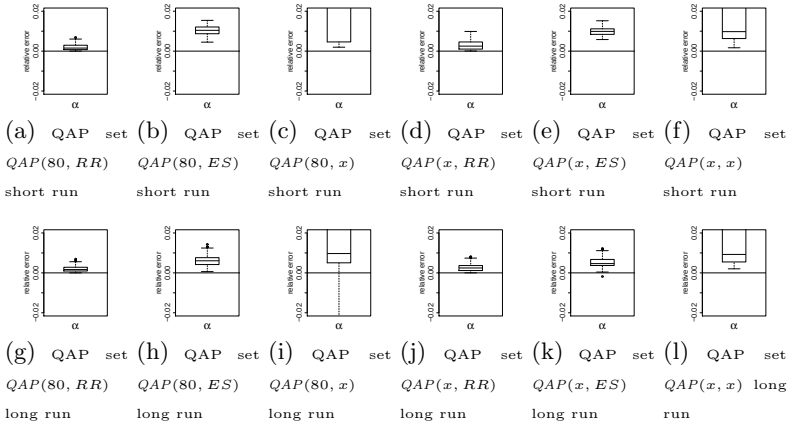
Fig. 58: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAa



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

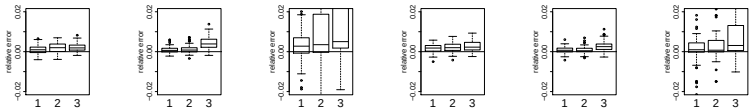
Fig. 59: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: LS



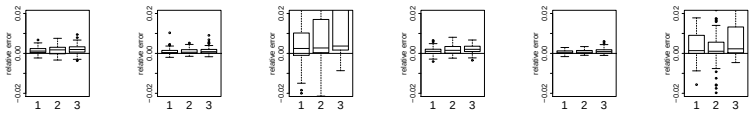
(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

Fig. 60: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the parameter adapted. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: LS

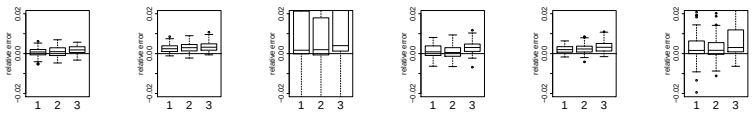


(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

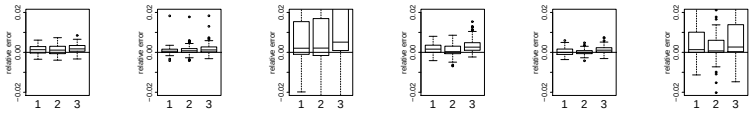


(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

Fig. 61: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAc

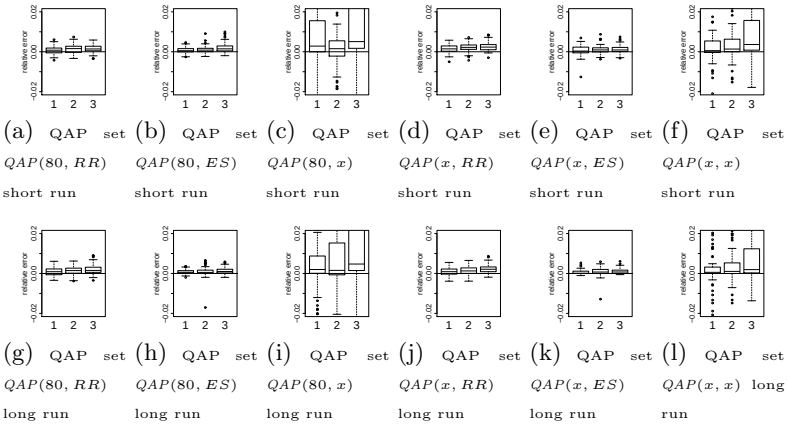


(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run



(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

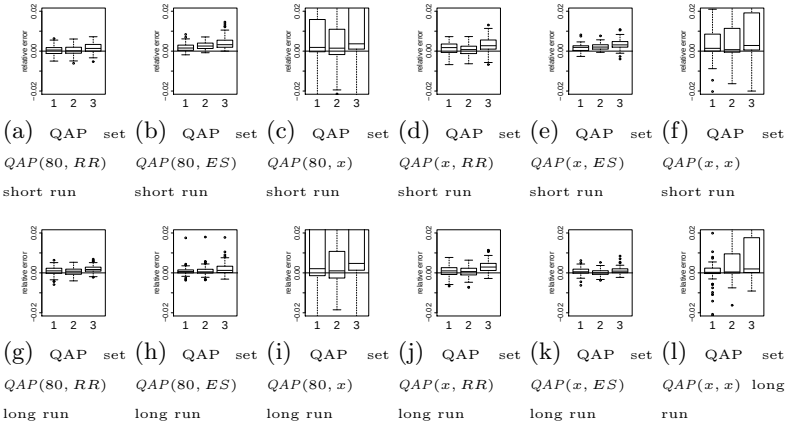
Fig. 62: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAc



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

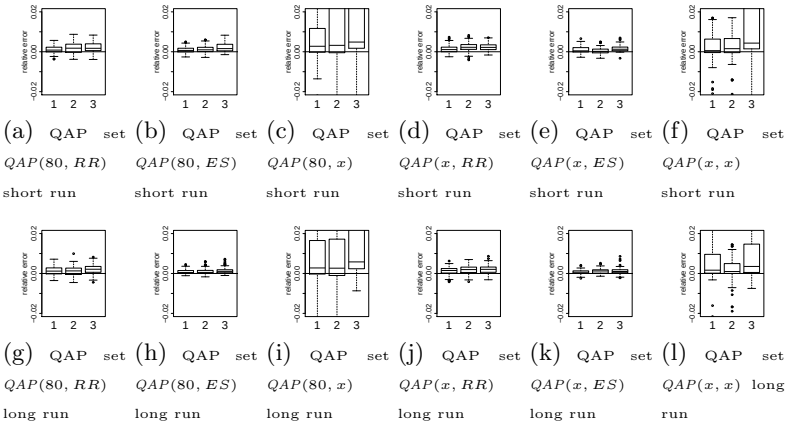
Fig. 63: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAcb



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

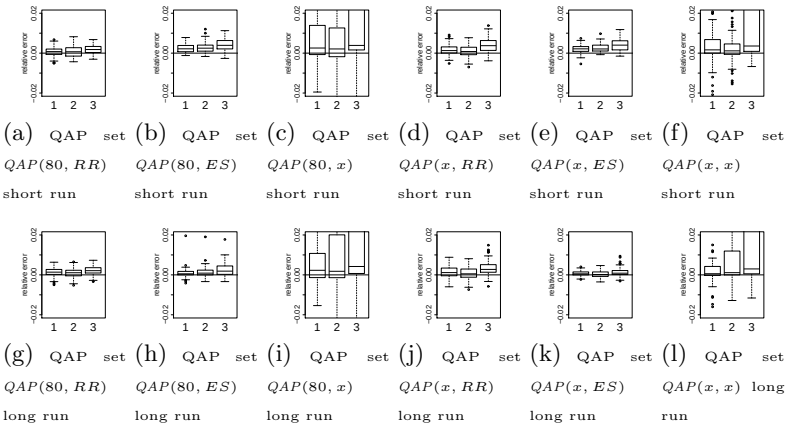
Fig. 64: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAcb



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

Fig. 65: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as selected with high tuning effort. Adaptation method: SAcm



(a) QAP set $QAP(80, RR)$ short run (b) QAP set $QAP(80, ES)$ short run (c) QAP set $QAP(80, x)$ short run (d) QAP set $QAP(x, RR)$ short run (e) QAP set $QAP(x, ES)$ short run (f) QAP set $QAP(x, x)$ short run

(g) QAP set $QAP(80, RR)$ long run (h) QAP set $QAP(80, ES)$ long run (i) QAP set $QAP(80, x)$ long run (j) QAP set $QAP(x, RR)$ long run (k) QAP set $QAP(x, ES)$ long run (l) QAP set $QAP(x, x)$ long run

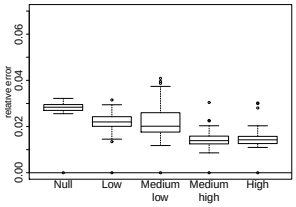
Fig. 66: QAP: Relative error made adapting parameters with respect to adapting none. The x axis reports the cardinality of the set. Setting of the non-adapted parameters as suggested in the literature. Adaptation method: SAcm

Table 7: Average relative error with respect to the optimal solution when no parameter is adapted

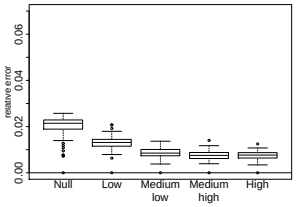
set	runtime	literature	low tuning effort	medium-low tuning effort	medium-high tuning effort	high tuning effort
$TSP(2000, u)$	short	0.02810	0.02198	0.02184	0.01437	0.01471
$TSP(2000, u)$	long	0.02013	0.01313	0.00872	0.00756	0.00748
$TSP(2000, c)$	short	0.04833	0.03510	0.03822	0.03687	0.03720
$TSP(2000, x)$	short	0.03434	0.03152	0.03004	0.03101	0.02716
$TSP(x, u)$	short	0.02370	0.01489	0.01596	0.01158	0.01162
$TSP(x, c)$	short	0.03880	0.02595	0.02961	0.02738	0.02732
$TSP(x, x)$	short	0.03174	0.02528	0.02533	0.02447	0.01997

Table 8: Average relative error with respect to the best-known solution when no parameter is adapted

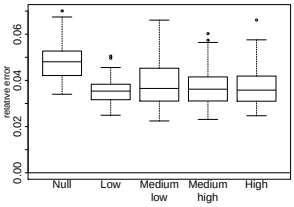
set	runtime	literature	high tuning effort
$QAP(80, RR)$	17	0.00648	0.00117
$QAP(80, RR)$	29	0.00560	0.00070
$QAP(80, ES)$	17	0.00375	0.00308
$QAP(80, ES)$	29	0.00278	0.00253
$QAP(80, x)$	17	0.02483	0.03386
$QAP(80, x)$	29	0.01842	0.02816
$QAP(x, RR)$	17	0.00644	0.00119
$QAP(x, RR)$	29	0.00555	0.00087
$QAP(x, ES)$	17	0.00328	0.00297
$QAP(x, ES)$	29	0.00267	0.00247
$QAP(x, x)$	17	0.02533	0.02457
$QAP(x, x)$	29	0.02284	0.01693



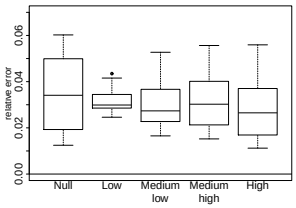
(a) set $TSP(2000, u)$
short runtime



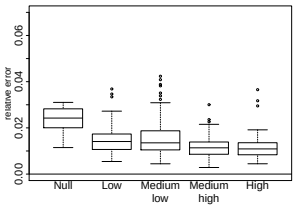
(b) set $TSP(2000, u)$
long runtime



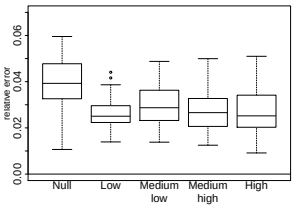
(c) set $TSP(2000, c)$
short runtime



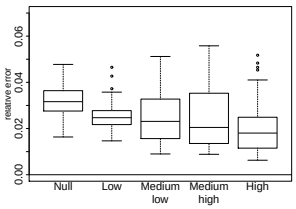
(d) set $TSP(2000, x)$
short runtime



(e) set $TSP(x, u)$
short runtime

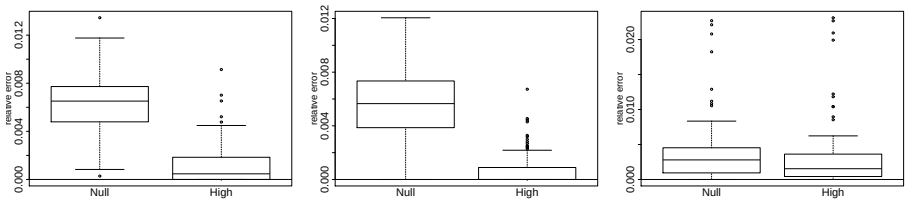


(f) set $TSP(x, c)$
short runtime



(g) set $TSP(x, x)$
short runtime

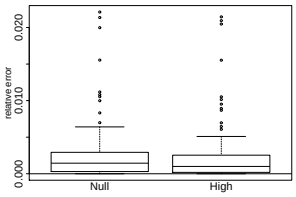
Fig. 67: Boxplots of the relative error with respect to the optimal solution when no parameter is adapted. **TSP** instances.



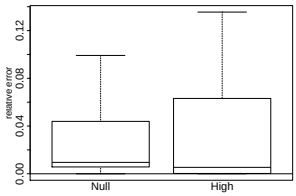
(a) set $QAP(80, RR)$
short runtime

(b) set $QAP(80, RR)$
long runtime

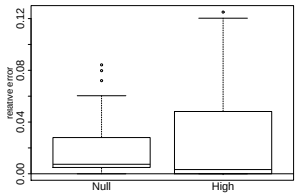
(c) set $QAP(80, ES)$
short runtime



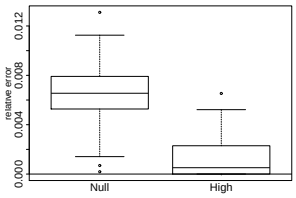
(d) set $QAP(80, ES)$
long runtime



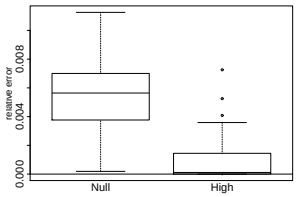
(e) set $QAP(80, x)$
short runtime



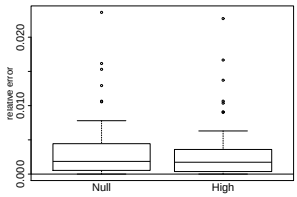
(f) set $QAP(80, x)$
long runtime



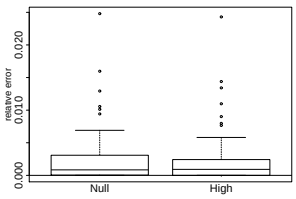
(g) set $QAP(x, RR)$
short runtime



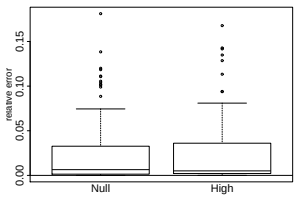
(h) set $QAP(x, RR)$
long runtime



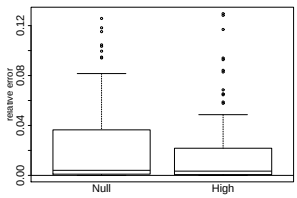
(i) set $QAP(x, ES)$
short runtime



(j) set $QAP(x, ES)$
long runtime



(k) set $QAP(x, x)$
short runtime



(l) set $QAP(x, x)$
long runtime

Fig. 68: Boxplots of the relative error with respect to the best-known solution when no parameter is adapted. **QAP** instances.

Table 9: Average relative error for each set of instances of the **TSP**. Comparison between $\mathcal{MM}$AS applying the parameter adaptation method SAc and applying no adaptation.SAc is tuned off-line specifically for each instance set and each runtime: its non-adapted parameters are fixed as returned by this tuning. Results obtained adapting each single parameter. A bullet following the value indicates that no adaptation is statistically better than adaptation. A star indicates that no adaptation is statistically worse than adaptation.

instance set	runs	q_0	β	ρ	m	α	nn
Low tuning effort							
$TSP(2000,u)$	short	$.0101^{\bullet}$	$.0120^{\bullet}$	$.0093^{\bullet}$	$.0085^{\bullet}$	$.0152^{\bullet}$	$.0119^{\bullet}$
$TSP(2000,c)$	short	$-.0018^{\star}$	$-.0050^{\star}$	$-.0025^{\star}$	$.0010^{\bullet}$	$-.0034^{\star}$	$-.0012^{\star}$
$TSP(2000,x)$	short	$.0060^{\bullet}$	$.0058^{\bullet}$	$.0040^{\bullet}$	$.0043^{\bullet}$	$.0091^{\bullet}$	$.0049^{\bullet}$
$TSP(x,u)$	short	$.0116^{\bullet}$	$.0138^{\bullet}$	$.0161^{\bullet}$	$.0113^{\bullet}$	$.0137^{\bullet}$	$.0168^{\bullet}$
$TSP(x,c)$	short	$-.0006^{\star}$	$-.0003$	$-.0030^{\star}$	$-.0021^{\star}$	$.0001$	$.0015^{\bullet}$
$TSP(x,x)$	short	$.0015^{\bullet}$	$.0040^{\bullet}$	$.0011^{\bullet}$	$.0030^{\bullet}$	$.0044^{\bullet}$	$.0039^{\bullet}$
$TSP(2000,u)$	long	$.0116^{\bullet}$	$.0134^{\bullet}$	$.0125^{\bullet}$	$.0124^{\bullet}$	$.0162^{\bullet}$	$.0120^{\bullet}$
Medium-low tuning effort							
$TSP(2000,u)$	short	$.0091^{\bullet}$	$.0096^{\bullet}$	$.0087^{\bullet}$	$.0083^{\bullet}$	$.0100^{\bullet}$	$.0123^{\bullet}$
$TSP(2000,c)$	short	$.0043^{\bullet}$	$.0094^{\bullet}$	$.0048^{\bullet}$	$.0041^{\bullet}$	$.0121^{\bullet}$	$.0143^{\bullet}$
$TSP(2000,x)$	short	$.0117^{\bullet}$	$.0109^{\bullet}$	$.0081^{\bullet}$	$.0092^{\bullet}$	$.0106^{\bullet}$	$.0096^{\bullet}$
$TSP(x,u)$	short	$.0099^{\bullet}$	$.0097^{\bullet}$	$.0121^{\bullet}$	$.0125^{\bullet}$	$.0167^{\bullet}$	$.0112^{\bullet}$
$TSP(x,c)$	short	$.0038^{\bullet}$	$.0078^{\bullet}$	$.0069^{\bullet}$	$.0079^{\bullet}$	$.0085^{\bullet}$	$.0094^{\bullet}$
$TSP(x,x)$	short	$.0070^{\bullet}$	$.0066^{\bullet}$	$.0109^{\bullet}$	$.0101^{\bullet}$	$.0088^{\bullet}$	$.0095^{\bullet}$
$TSP(2000,u)$	long	$.0149^{\bullet}$	$.0158^{\bullet}$	$.0161^{\bullet}$	$.0163^{\bullet}$	$.0226^{\bullet}$	$.0174^{\bullet}$
Medium-high tuning effort							
$TSP(2000,u)$	short	$.0135^{\bullet}$	$.0144^{\bullet}$	$.0168^{\bullet}$	$.0173^{\bullet}$	$.0176^{\bullet}$	$.0179^{\bullet}$
$TSP(2000,c)$	short	$.0043^{\bullet}$	$.0036^{\bullet}$	$.0070^{\bullet}$	$.0041^{\bullet}$	$.0088^{\bullet}$	$.0102^{\bullet}$
$TSP(2000,x)$	short	$.0055^{\bullet}$	$.0063^{\bullet}$	$.0071^{\bullet}$	$.0057^{\bullet}$	$.0075^{\bullet}$	$.0085^{\bullet}$
$TSP(x,u)$	short	$.0138^{\bullet}$	$.0143^{\bullet}$	$.0169^{\bullet}$	$.0143^{\bullet}$	$.0187^{\bullet}$	$.0152^{\bullet}$
$TSP(x,c)$	short	$.0065^{\bullet}$	$.0090^{\bullet}$	$.0087^{\bullet}$	$.0076^{\bullet}$	$.0099^{\bullet}$	$.0119^{\bullet}$
$TSP(x,x)$	short	$.0080^{\bullet}$	$.0100^{\bullet}$	$.0097^{\bullet}$	$.0090^{\bullet}$	$.0117^{\bullet}$	$.0095^{\bullet}$
$TSP(2000,u)$	long	$.0163^{\bullet}$	$.0163^{\bullet}$	$.0158^{\bullet}$	$.0168^{\bullet}$	$.0184^{\bullet}$	$.0178^{\bullet}$
High tuning effort							
$TSP(2000,u)$	short	$.0132^{\bullet}$	$.0142^{\bullet}$	$.0165^{\bullet}$	$.0170^{\bullet}$	$.0173^{\bullet}$	$.0176^{\bullet}$
$TSP(2000,c)$	short	$.0039^{\bullet}$	$.0033^{\bullet}$	$.0067^{\bullet}$	$.0038^{\bullet}$	$.0085^{\bullet}$	$.0098^{\bullet}$
$TSP(2000,x)$	short	$.0092^{\bullet}$	$.0100^{\bullet}$	$.0109^{\bullet}$	$.0094^{\bullet}$	$.0112^{\bullet}$	$.0122^{\bullet}$
$TSP(x,u)$	short	$.0137^{\bullet}$	$.0143^{\bullet}$	$.0169^{\bullet}$	$.0143^{\bullet}$	$.0186^{\bullet}$	$.0151^{\bullet}$
$TSP(x,c)$	short	$.0065^{\bullet}$	$.0090^{\bullet}$	$.0087^{\bullet}$	$.0075^{\bullet}$	$.0098^{\bullet}$	$.0118^{\bullet}$
$TSP(x,x)$	short	$.0123^{\bullet}$	$.0143^{\bullet}$	$.0140^{\bullet}$	$.0133^{\bullet}$	$.0160^{\bullet}$	$.0138^{\bullet}$
$TSP(2000,u)$	long	$.0163^{\bullet}$	$.0163^{\bullet}$	$.0158^{\bullet}$	$.0168^{\bullet}$	$.0184^{\bullet}$	$.0178^{\bullet}$

Table 10: Average relative error for each set of instances of the **QAP**. Comparison between $\mathcal{MM}$AS applying the parameter adaptation method SAc and applying no adaptation. SAc is tuned off-line specifically for each instance set and each runtime: its non-adapted parameters are fixed as returned by this tuning. Results obtained adapting each single parameter. A bullet following the value indicates that no adaptation is statistically better than adaptation. A star indicates that no adaptation is statistically worse than adaptation.

instance set	runs	m	ρ	α
$QAP(80, RR)$	short	$.0003^{\bullet}$	$.0002^{\bullet}$	$.0013^{\bullet}$
$QAP(80, RR)$	long	$.0005^{\bullet}$	$.0005^{\bullet}$	$.0022^{\bullet}$
$QAP(80, 72)$	short	$.0005^{\bullet}$	$.0005^{\bullet}$	$.0005^{\bullet}$
$QAP(80, 72)$	long	$.0003^{\bullet}$	$.0004^{\bullet}$	$.0005^{\bullet}$
$QAP(80, x)$	short	$.0038^{\bullet}$	$.0029^{\bullet}$	$.0172^{\bullet}$
$QAP(80, x)$	long	$.0000^{\bullet}$	$.0019^{\bullet}$	$.0112^{\bullet}$
$QAP(x, RR)$	short	$.0000^{\bullet}$	$.0002^{\bullet}$	$.0014^{\bullet}$
$QAP(x, RR)$	long	$.0000^{\bullet}$	$.0002^{\bullet}$	$.0009^{\bullet}$
$QAP(x, 72)$	short	$.0006^{\bullet}$	$.0009^{\bullet}$	$.0004^{\bullet}$
$QAP(x, 72)$	long	$.0007^{\bullet}$	$.0005^{\bullet}$	$.0007^{\bullet}$
$QAP(x, x)$	short	$.0042^{\bullet}$	$.0037^{\bullet}$	$.0156^{\bullet}$
$QAP(x, x)$	long	$.0013^{\bullet}$	$.0034^{\bullet}$	$.0119^{\bullet}$